THE POLAR RECORD

VOL. 9, NO. 61, JANUARY 1959

A Journal of Arctic and Antarctic Exploration and Research

Issued by the Scott Polar Research Institute, Cambridge

os. 6d.

THE POLAR RECORD

Editor: L. M. Forbes. Editorial Committee: B. B. Roberts, G. de Q. Robin, Sir J. M. Wordie

Vol. 9 January 1959 No. 61

CONTENTS

The Scott Polar Research Institute . . . . . *page* 297

ARTICLES:

The Canadian Northern Insect Survey, 1947–57. By T. N. Freeman 299
Recent economic developments in northern Quebec and Labrador. By J. Brian Bird 308
Iron ore in Arctic Europe. By P. A. B. Gethin 314
Geodetic survey of northern Canada by shoran trilateration. By Angus C. Hamilton 320
The manuscript collection of the Scott Polar Research Institute. By Ann Savours 331

FIELD WORK:

British expedition to Vestspitsbergen, 1956 336
French expedition to central Greenland, 1956–57 336
British expedition to north-west Greenland, 1957 336
Soviet Arctic expeditions, 1957 337
The Northern Sea Route in 1957 337
Swedish–Finnish–Swiss International Geophysical Year Expedition to Nordaustlandet, 1957–58; and Swedish Expedition to Nordaustlandet, 1958–59: Season 1957–58 338
Swedish Glaciological Expedition to Nordaustlandet, 1958 . . 339
Under-ice crossing of the Arctic basin: U.S.S. *Nautilus* and U.S.S. *Skate*, 1958 340
Arctic Institute Greenland Expedition, 1958 341
British naval hydrographic surveys in the Falkland Islands Dependencies, 1956–57 and 1957–58 341
The Australian automatic weather station on Lewis Islet, Wilkes Land 342
Anglo-American physiological team in Ross Dependency, 1957–58 . 343

NOTES:

Extension of International Geophysical Year activities into 1959 . 345
Norwegian–Soviet sealing agreement, 1958 345
Tenth meeting of the International Whaling Commission, 1958 . 349
New Soviet ice-strengthened ships 350
New geographical institute in Siberia 350

NOTES (*cont.*)

Soviet organizations concerned with the Antarctic . . . *page* 350
École des Hautes Études: Centre Français d'Études Arctiques . 351
Alaska becomes 49th state of United States 351
The North American "Distant Early Warning Line" . . . 352
Proposed international Antarctic conference 353
IGY Antarctic Weather Central at "Little America V" . . . 355
The names "East Antarctica" and "West Antarctica" . . . 358

S.C.A.R. Bulletin 360

CORRESPONDENCE 373

OBITUARY 376

RECENT POLAR LITERATURE 378

ERRATA 407

Thirty-first Annual Report of the work of the Scott Polar Research Institute 408

THE SCOTT POLAR RESEARCH INSTITUTE

The change in status of the Scott Polar Research Institute within the University of Cambridge, the arrival of a new director, and the rapidity of scientific and technical developments in polar regions have naturally had their effect on the outlook and policy of the Institute. The text of the new constitution was published in the *Polar Record*, Vol. 9, No. 56, May 1957, and the present aims of the Institute are best summarized in a sentence from the report of the General Board of the University:

> The General Board appreciate the obligation which the Institute has as an established centre of polar research and information in the national and international field, and they hope that the more stable constitution now proposed for the Institute will enable the Institute to meet those obligations while at the same time bringing it fully within the main stream of University teaching and research.

In order to meet these outside obligations we shall need the continued services of a small experienced group to run the library, information service, *Polar Record* and museum.

Recently an interesting call on the editorial services of the Institute was made by the newly formed "Special Committee on Antarctic Research" (S.C.A.R.) of the International Council of Scientific Unions. S.C.A.R. has asked the Institute to publish a special "S.C.A.R. Bulletin" in co-operation with the Arctic and Antarctic Research Institute, Leningrad. This bulletin will be edited in the Institute and published in the *Polar Record*; it will also be distributed internationally under a separate cover. A Russian translation will be published officially in Leningrad. Much of the material, which will not be copyright, will be the same type of factual information which is normally presented by the *Polar Record*. However, as an official organ of S.C.A.R., a record of meetings and decisions will also be included, particularly in the first number.

This request is a striking confirmation of the reputation which my predecessors and the staff have built up for the Institute. It is perhaps as a centre for the collection and dissemination of information that the Institute is best known overseas, but a number of valuable research projects have been carried out by members of the staff and visiting research workers. The unique collections of books, maps, manuscripts, paintings and museum exhibits are also widely appreciated. We must do all we can to maintain this reputation, but at the same time, as a sub-department of the University, we should strengthen our teaching and research activities. The library will of course continue to provide opportunities for historical and other types of bibliographical research, as well as providing an excellent background for teaching and field research. Other ways of integrating the Institute into the University structure are also under consideration, and the following developments have already been planned for the coming year. Two short lecture courses will be given by members of the staff in Part II of the Geographical Tripos. A new

series of lectures on polar techniques, open to all, but intended primarily to stimulate undergraduate interest in polar matters, will be held during the Lent term. Opportunities for co-operation with University scientific departments will be sought with the object of providing stimulation in both directions. As a first step Dr Stanley Evans is to take up an appointment as a Senior Assistant in Research on the staff of the Institute in January 1959. He is at present a lecturer in physics on the staff of the University of Manchester, at the Jodrell Bank Radio Astronomy Station. Dr Evans spent 1956 at the Royal Society Base, Halley Bay, where he initiated auroral studies. His first task in the Institute will be to take part in working up the IGY auroral results from Halley Bay, and he will also co-operate in experimental work with the radio astronomy unit in the Cavendish Laboratory.

Another form of University activity is the increasing use of the Institute by research students working for higher degrees. During the coming year four students will be officially attached to the Institute for this purpose, two of whom have come on grants from the United States. Although the investigations of these students are centred on the Institute, their work frequently involves contact with other University departments, which again helps to integrate the Institute into the University structure.

The Institute is developing both as a national and international centre of polar information, and as a University subdepartment. There is no sharp dividing line between these two functions. The most serious problem to be faced in the near future is the need of more space, as the library, research and museum space is already overtaxed. If the problem can be overcome, the Institute should continue to fulfil its role in the rapidly expanding sphere of polar research.

December 1958 G. DE Q. ROBIN

THE CANADIAN NORTHERN INSECT SURVEY, 1947–57[1]

BY T. N. FREEMAN[2]

[*MS. received 2 April 1958.*]

CONTENTS

Object . . . . . *page* 299
Extent of investigations . . . 299
Results 303
Bibliography of Northern Insect Survey . . . . . *page* 305

Object

The study of the insects of northern Canada has in the past depended mainly on a very small number of collections obtained by the early explorers, by a few individuals concerned with mapping and other scientific investigations, and by missionaries. The work of Kirby (1837), the reports of the Canadian Arctic Expedition (Hewitt, 1922) and the Fifth Thule Expedition (Henriksen, 1937), and a few short papers represent the main contributions of many years.

Organized entomological research in northern Canada began in 1947 as a joint project of the Defence Research Board of the Canada Department of National Defence, and the Divisions of Entomology, Botany and Plant Pathology of the Canada Department of Agriculture. The research programme was divided into three major phases:

(1) Investigations of life-history, habits, ecology, and control of biting flies—by the Veterinary and Medical Entomology Unit of the Entomology Division; (2) the Northern Insect Survey, which deals with systematics, distribution, relative abundance, and ecology of biting flies and other insects—by the Insect Systematics and Biological Control Unit of the Entomology Division, and the Botany Unit of the Botany and Plant Pathology Division; and (3) investigations on laboratory rearing techniques for northern mosquitoes, and on behaviour and systematics of some mosquitoes of the genus *Aedes*—by the Defence Research Board at the Defence Research Northern Laboratory, Fort Churchill, Manitoba.

This article deals with the second phase, the Northern Insect Survey.

Extent of investigations

Sixty localities have been investigated by sixty-two field parties since the Survey began (see map). Occasionally a field party stationed at one locality conducted a short investigation at a nearby locality. These are included on the map in addition to the sixty main localities. Each party usually consists of two men, and only two localities, Eureka Sound, Ellesmere Island, and

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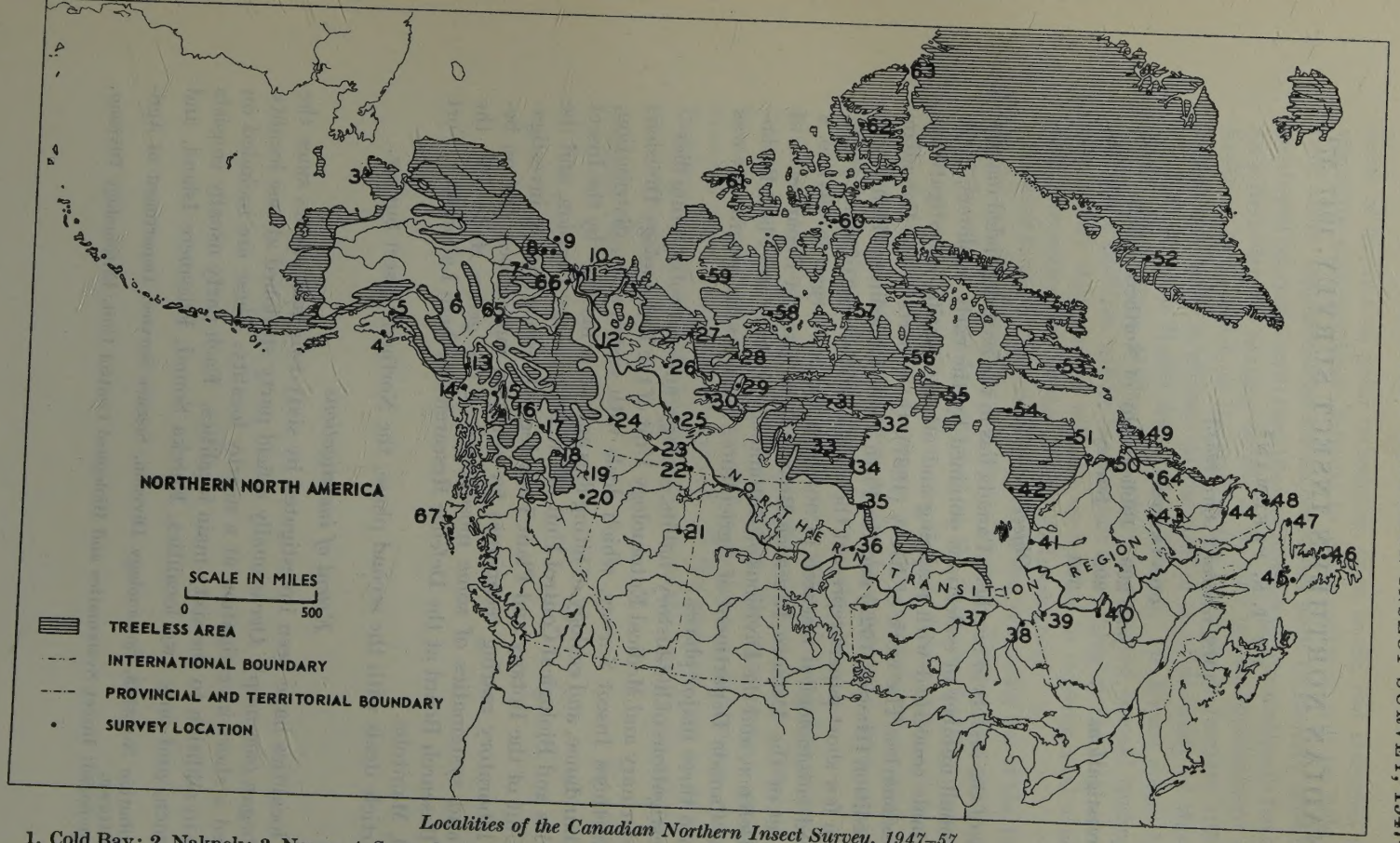

Localities of the Canadian Northern Insect Survey, 1947–57

1, Cold Bay; 2, Naknek; 3, Nome; 4, Seward; 5, Anchorage; 6, Big Delta; 7, Rampart House; 8, Firth River; 9, Herschel Island; 10, Kidluit Bay; 11, Reindeer Depot; 12, Norman Wells; 13, Burwash Landing; 14, Hain's Cut Off; 15, Whitehorse; 16, Atlin Lake; 17, Watson Lake (Lower Post); 18, Muncho Lake; 19, Fort Nelson; 20, Dawson Creek (13–15, 16–20, Alaska Highway Expedition); 21, Fort McMurray; 22, Fort Smith; 23, Hay River; 24, Fort Simpson; 25, Yellowknife; 26, Saw Mill Bay; 27, Coppermine; 28, Bathurst Inlet; 29, Muskox Lake; 30, MacKay Lake; 31, Baker Lake; 32, Chesterfield; 33, Padlei; 34, Eskimo Point; 35, Churchill; 36, Gillam; 37, Ogoki Post; 38, Moosonee; 39, Rupert House; 40, Mistassini Post; 41, Great Whale River; 42, Port Harrison; 43, Knob Lake; 44, Goose Bay; 45, Harmond Field; 46, Gander; 47, St Anthony; 48 Cartwright; 49, Hebron; 50, Fort Chimo; 51, Povungnetuk; 52, Stanley Stanfield; 53, Padlei; 54, Eskimo Point; 55, Churchill; 56, Gillam; 57, Ogoki Post; 58, Moosonee; 59, Rupert House; 60, Mistassini Post; 61, Great Whale River; 62, Port Harrison; 63, Knob Lake; 64, Goose Bay; 65, Harmond Field; 66, Gander; 67, St Anthony

Coral Harbor, Southampton Island, were surveyed a second time. The studies conducted in 1952 at Fort Churchill represented a departure from the usual objectives. Instead, an ecological study was made to determine the number of biotopes characteristic of the Arctic and sub-Arctic, and to ascertain which insect species are indicators of the various biotopes (Klots, in press). Various species of butterfly were investigated as possible indicators because of the ease of obtaining field identifications required for the studies. This involved the rearing of several butterfly species and yielded immature stages and new information on food plants, larval habits, and life histories.

The investigations were conducted from Nome, Alaska, to western Greenland and north to Alert in northern Ellesmere Island. The major localities investigated were:

1947. One party.	Northwest Territories: Baker Lake
1948. Eight parties.	Alaska Highway: Dawson Creek to Snag Newfoundland: Goose Bay Northwest Territories: Frobisher Bay, Coral Harbor, Saw Mill Bay, Reindeer Depot Quebec: Knob Lake, Fort Chimo
1949. Eleven parties.	Manitoba: The Pas to Churchill Newfoundland: Harmond Field, Gander Northwest Territories: Yellowknife, Norman Wells, Resolute Ontario: Moosonee Quebec: Rupert House, Great Whale River, Port Harrison Yukon: Dawson
1950. Eight parties.	Manitoba: Gillam Northwest Territories: Eskimo Point, Padlei, Chesterfield, Repulse Bay, Fort Smith, Fort Simpson, Cambridge Bay
1951. Eleven parties.	Alaska: Seward, Anchorage, Big Delta, Nome Newfoundland: St Anthony Northwest Territories: Hay River, Coppermine, Bathurst Inlet, Spence Bay, Alert Yukon: Rampart House
1952. Eight parties.	Alaska: Naknek, Cold Bay Greenland: Sondre Stromfjord Manitoba: Fort Churchill Northwest Territories: Coral Harbour, Holman Island, Mould Bay Ontario: Ogoki River Post
1953. Four parties.	Alberta: Fort McMurray Northwest Territories: Muskox Lake (lat. 64° 38′ N., long. 108° 15′ W.), Eureka Sound Yukon: Herschel Island
1954. Five parties.	Newfoundland: Hebron Northwest Territories: Eureka Sound Quebec: Indian House Lake, Payne Bay, Sugluk

1955. Two parties.	British Columbia: Atlin Lake Newfoundland: Cartwright
1956. Two parties.	Quebec: Mistassini Post Yukon: Firth River
1957. Two parties.	British Columbia: Queen Charlotte Islands Northwest Territories: Fort McPherson

Since the beginning of the Survey, every attempt has been made to supplement the meagre insect collections made by members of various scientific expeditions, from the time of such early explorers as Sir John Franklin (1825) and others, who were searching for the North West Passage. This was necessary to help untangle the numerous problems of nomenclature that existed because of the lack of specimens in North American collections.

The Survey began as a one-man expedition (myself) to Baker Lake in 1947. This locality was chosen for two reasons: (1) it represented a life zone different from that being investigated at Fort Churchill on the ecology and control of biting flies; and (2) at this locality it would be possible to supplement the small collections made by the Tyrrell brothers in 1893, by Hanbury in 1899, and by the Fifth Thule Expedition of 1921–24.

The Spence Bay investigations supplemented the insect collections made by Commander J. C. Ross during his expedition of 1829–33. Similarly, the party at Alert supplemented those of the Nares Expedition in 1875–76. The Cambridge Bay collections increased our knowledge of the insects collected by Captain R. Collinson in 1850–55.

The Fort McMurray party made general insect collections to supplement those made in the area during the nineteenth century. The first collecting here was done by Dr John Richardson, surgeon of the Second Franklin Expedition, 1825–27. The next, and probably the last collecting in the area before 1953, was done from 1859 to 1862 by Robert Kennicott, who was employed by the Smithsonian Institution. Several species of insects were described by early taxonomists from material collected by Richardson and Kennicott, and the collection obtained at Fort McMurray contained, therefore, topotypical specimens.

The Hebron investigations extended the insect collections that have been made from time to time during the past 250 years by Moravian missionaries along the Labrador coast. Some of that material had been sent to such pioneer entomologists as Fabricius and Huebner during the first quarter of the nineteenth century. They described many new species from these early collections, and the Hebron material obtained during the 1954 survey also contained a great many topotypical specimens.

The Cartwright investigations supplemented and extended the collections made along the southern coast of Labrador by Grenfell medical missionaries, mainly during the last quarter of the nineteenth century.

Except for a few specimens collected about 1900 by officers of the Geological Survey of Canada and of the International Boundary Commission, and later by officers of the British Columbia Provincial Museum, the Atlin Lake district had had no extensive entomological investigation.

The Ogoki River party was designed, in addition to the main objective, to obtain topotypical specimens of species described from the region by Sir Francis Walker about the middle of the last century. Walker's material was collected by several individuals on various missions along one of the historic canoe routes to the west via the Albany River, and sent to the British Museum.

Results

Although all the results and implications of this extensive survey have not yet been fully realized, much interesting and valuable information has been accumulated, and a large number of papers have been published on insect taxonomy and other sciences than entomology. I shall mention a few of the results.

Approximately three-quarters of a million specimens have been obtained for study. From this material, many species have been described as new and many remain to be described. Significant extensions of known distributions have been determined, and distributional patterns have become manifest. Perhaps the most significant are those that suggest post-glacial lines of invasion, regions of Pleistocene refugia, and continuity of pre-glacial land masses in the Holarctic regions. In addition, many distributional patterns are associated with the presence or absence of trees. In some instances, summer isotherms appear to coincide with the northern limits of Arctic species. Other factors that influence distribution are the presence or absence of permafrost, and the type of underlying geological formation.

In Canada, the northern limit of trees is the northern limit of many insect groups, including all Orthoptera, Odonata, ants, wasps, and bees (except a few species of *Bombus*), and almost all Homoptera and Heteroptera. Most of the sub-Arctic and Arctic genera are Holarctic. For the most part there are no rare species in the Arctic, but rather great numbers of a few species. This is probably due to the general lack of ecological diversity, as well as to lack of adaptation by most insect species to the rigorous climatic conditions.

The studies have shown that geographical variation exists in many Arctic species, and insular subspeciation frequently occurs. This is particularly evident in the Lepidoptera, and apparently exists only on the islands of the Arctic archipelago in the north-west and on southern Baffin Island in the north-east. Other subspecies occur as relic populations in the arctic-alpine regions of the Gaspé and the Appalachian system in Maine and New Hampshire. In contrast to this discontinuity of variation, the lepidopterous species exhibit clinical variation, usually in a north to south or north-west to south-east direction, in the vast interior of the continental Arctic region. The geographical variation within the range of the species follows the distributional patterns east and west, and north and south. As an example, many of the northern butterfly species become darker and more hairy in the northern portion of their range. This is probably an adaptation that enables the adult butterflies to absorb the heat from solar radiation, and allows them to be active when the sun is shining, even though the air temperature is too low for normal activity.

The distribution of butterflies within the Arctic and sub-Arctic regions east of the Cordilleran system shows four main patterns: (1) those that are indigenous to the Arctic only, (2) those that extend from the northern Canadian region through the Hudsonian into the Arctic, (3) those that appear to inhabit the Hudsonian zone only, and (4) those that occur in both the Canadian and the Hudsonian zones. These main distributional patterns may be further subdivided into transcontinental, eastern, western, northern or southern sections.

The distribution patterns suggest three main refugia for these butterflies during the Pleistocene period: (1) in the Cordilleran system particularly in the north-west; (2) south of the ice, at least in the Appalachian region; and (3) north of the ice in the eastern Queen Elizabeth Islands and Greenland. The western Queen Elizabeth Islands are apparently devoid of Lepidoptera and other insect groups. Either climatic conditions are unfavourable for their existence or sufficient time has not elapsed since the Pleistocene era to enable them to become established.

Problems of distribution are very complex. Along the Mackenzie River the Boreal forest and Boreal insects penetrate almost to the Arctic Ocean. There the effect of the continuous summer daylight on behaviour, particularly of those nocturnal species whose distributions extend southward into the regions of regular day and night, should be investigated, and may help to explain distribution patterns elsewhere. Many of the Arctic insects intrude on the northern fringe of the Boreal forest, and some Boreal species intrude on the Arctic region, for example, in Bathurst Inlet, although Freeman (1952*a*) postulated the principle that Arctic and Boreal insects are specifically distinct. The extent of these intrusions from one zone to another is not well known or understood. When they are mapped it may be possible to define the Northern Transition zone more precisely.

Distribution patterns may depend, to a greater or lesser degree, on the soil types and underlying rock formations. For instance, the North American subspecies *Papilio machaon aliaska* Scud. inhabits the Canadian and Hudsonian regions from Alaska south-east to the southern shore of James Bay. Throughout its range it has so far only been taken in areas with basic sedimentary formations, and not in those with intrusive acid rock such as that of the granitic Shield.

Boloria pales D. & S. has apparently migrated south-east from a Pleistocene refugium in the north-west in the post-glacial era. This species appears to be restricted to the Precambrian, Paleozoic, and Mesozoic sedimentary formations in arctic regions. The records for *pales* show a general distribution from the Yukon near the Alaskan border, east along the mainland coast to Bathurst Inlet, and south-east along a relatively narrow, sedimentary band to the edge of the granitic Shield at Baker Lake. Several Northern Insect Survey parties have been stationed on the Shield surrounding that sedimentary band, but *pales* was not taken except on the sediments.

The factors that govern this type of distribution are, no doubt, numerous complexities of biological and physical components. Nevertheless, in some

instances, a distributional pattern associated with another factor may be used as a specific character.

Holland (in press) shows that some species of Siphonaptera apparently do not occur throughout the geographic ranges of their hosts. This suggests that these insects are more sensitive to the terrestrial environment than the hosts, and it is the terrestrial environment that limits their distributional ranges. It is apparent that taxonomic studies of the Siphonaptera help to elucidate the systematics of some taxonomically difficult mammal groups. Holland's work on the distributional patterns of the northern Siphonaptera shows that these patterns coincide with those of phytophagous species.

South Greenland and the Aleutian Islands, although treeless, do not have a typical Arctic fauna, but rather a mixture of Arctic and Boreal species. This suggests that these areas do not have an Arctic climate similar to that of Arctic Canada. It also suggests early land connexions with more southern latitudes. The insect fauna of north Greenland is closely affiliated with that of the Nearctic, that of south Greenland with that of the Palaearctic region.

The Survey also made possible the plotting of the known distribution of each species of mosquito, black fly, and tabanid of northern Canada. It is noteworthy that in the sub-Arctic the granitic rocks, with their juvenile drainage system and resistance to rapid erosion, are characterized by much fast water and thus favour the abundance of black flies. On the other hand, the flat sedimentary rocks in this region promote the formation of swamps and bogs, the favourite habitat of mosquitoes and tabanids.

Survey data suggest that mosquitoes do not occur north of the mean July isotherm of 35° F. (1·7° C.). Also, the adults apparently emerge approximately four weeks after the mean temperature for 14 days reaches 34° F. (1·1° C.). The latter observation is based on a correlation of weather data and mosquito emergence from fourteen localities across the north during the past six years; observations were made at each locality for one season only and additional correlations are required. If these observations are well founded, the dates of mosquito emergence in the area can be predicted four weeks in advance.

The studies have also revealed the importance of the northern Canadian species in studies on Holarctic insects. It is apparent that the Arctic faunas of the Palaearctic and Nearctic regions are essentially one and should be studied as a whole. This was emphasized at a symposium, made possible by Survey findings, on the distribution of Arctic and sub-Arctic insects at the Tenth International Congress of Entomology, held in Montreal in 1956.

The above generalities outline the scope of the Survey and indicate some of the complexities and implications of insect surveys. The time has passed for scientific collecting trips to be designed solely to fill the gaps in insect cabinets.

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RECENT ECONOMIC DEVELOPMENTS IN NORTHERN QUEBEC AND LABRADOR

BY J. BRIAN BIRD*†

[*MS. received 28 May 1958.*]

About half a million square miles of Labrador and Quebec lie in the Arctic and sub-Arctic north of the closed-crown, boreal forest. Although the boundary between the unbroken coniferous forest and the open lichen woodlands has only recently been defined accurately,[1] it has been known for many years to correspond roughly to the 51° 30′ N. parallel except for a northern extension in the east to Lake Melville. This forest zonal division also marked approximately the northern boundary of the province of Quebec until the district of Ungava was incorporated into the province in 1912; in addition it forms the northern limit of logging operations by the pulp industry, and coincides roughly with the southern edge of the lake plateau that dominates the interior of the peninsula. Until the last few years the vast region was inhabited by less that 6000 Eskimos and Indians, a few traders, and, on the Labrador coast, small numbers of fishermen and their families.

On the north side of the woodlands and the forest tundra, the tree line stretches across the peninsula from Cape Jones on the west, along the Hudson Bay coast to Richmond Gulf and then trends inland towards Lake Minto and the south end of Ungava Bay. East of the mouth of George River it bends south avoiding the Torngat Mountains, reaches the coast near Nain and then continues southwards along the coastal islands to Strait of Belle Isle. Less than a quarter of the peninsula, therefore, lies north of the tree line and may be considered to lie in the Arctic, but because of the relief, poor drainage, rock outcrops and forest fires, vast areas of the whole peninsula are treeless.

It is impossible to generalize satisfactorily about the climate of so large an area. The winters on the whole are not for the most part exceptionally cold (Knob Lake has a mean January temperature of −11° F. or −24° C.) but the snowfall is heavy, exceeding 140 in. in the central part of the peninsula although appreciably less farther north. Semi-permanent snow-banks persist in many localities north of lat. 55° N. and there are small glaciers in the Torngat Mountains. The summers are cool inland (Knob Lake mean July temperature, 55° F. or 13° C.) and cold on the coast (Cape Hopes Advance 42° F. or 5° C.); they are also wet (Knob Lake has 9½ in. of rain in the three months June to August), cloudy and stormy. Permafrost is widespread. It is probably continuous in the northern third of the peninsula and sporadic permafrost is found as far south as Knob Lake.

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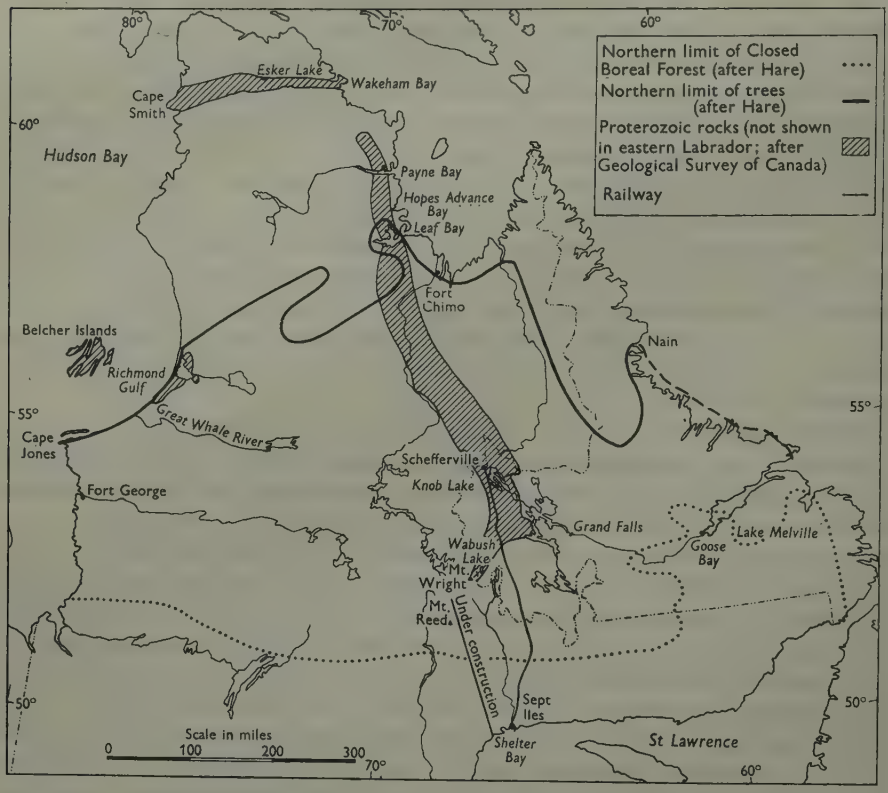
† I am indebted to G. Humphrys and G. H. Michie for information they supplied during the preparation of these notes.

The area was still largely unknown at the outbreak of World War II, particularly the interior which is isolated from the east and south coasts by the dissected edge of the lake plateau and which has few rivers easily navigable for canoes. A small number of exploratory traverses had been made across the peninsula and there had been a little prospecting, but settlement was restricted to small, isolated, fur trading posts all with two exceptions on the coast, and the Labrador fishing villages. The area was serviced by ships during the short summer season. During the early part of the war airfields were constructed at Goose Bay and Fort Chimo, and since then aircraft have played a major role in the rapid advances in scientific exploration and economic exploitation. Since 1954 the area has been photographed from the air twice, and in some parts three times, to obtain different scales and more accurate photographs. From the photographs maps have been prepared on a scale of 8 miles to 1 in. Some of these sheets have recently been contoured from radar altimetry. In addition, contoured maps on scales of 1:40,000 or 1:50,000 are available for many districts. In 1957 a tellurometer was used to establish survey control in the arctic sector. The natural vegetation and physiography have been mapped on the reconnaissance scale of 8 miles to 1 in. using a combination of field traverses and air photograph interpretation[2,3]; and geological mapping has been extended in many areas using fixed-wing aircraft and helicopters extensively. Facilities for scientific investigations have been created by the Province of Quebec at Fort Chimo and by McGill University at Schefferville.

The main economic expansion has been in the mining field. With the exception of a few very small patches of Palaeozoic sedimentary rocks, the Labrador–Quebec peninsula is underlain wholly by Precambrian rocks of the Canadian Shield. Despite the general geological unity of the area the rocks are of many varieties and ages. So far the most productive for mineral discoveries has been a belt of Proterozoic, folded rocks that extend in a band 10 to 60 miles wide from the centre of the peninsula for 600 miles to north of Payne Bay. This region, usually referred to as the Labrador trough, was first explored by A. P. Low at the end of the nineteenth century. Although he reported iron ore, his observations created little interest until further work, primarily of a prospecting nature for base metals, was carried out in the decade before 1939. These investigations suggested that iron ore might be found in quantity in the southern part of the trough, both in Quebec and Newfoundland–Labrador; however, at the time there was no demand for ore that was so inaccessible. World War II changed this situation. By 1945 the high grade ores at the head of Lake Superior were thought to be approaching exhaustion and a widespread search for ore was undertaken elsewhere. Exploration concessions in Labrador and Quebec were obtained by a number of companies and after a period of reorganization the Iron Ore Company of Canada was created in 1949 from Canadian and United States interests (the latter primarily from the Lake Erie–Ohio valley industrial region) to develop the ores with subsidiary companies. The following year 420 million tons of ore with an average of 55 per cent had been proved, and development started.

The ore bodies of the Knob Lake area are located in the geographical centre of the peninsula in a section of the Labrador trough where there are broad valleys separated by narrow ridges. The drier valleys are filled with open lichen and moss woodland, while muskeg and bog forest occupy the poorly drained sections. The ridges are covered with some variety of tundra.[4] The ore bodies are found in a narrow belt aligned with the trough on the Atlantic–Ungava Bay watershed. They are consequently on the disputed provincial boundary between Quebec and Newfoundland, and two ore bodies are actually cut by it.



Recent developments in northern Quebec and Labrador.

A charter as a common carrier was obtained by a subsidiary of the Iron Ore Company, the Quebec North Shore and Labrador Railway, to transport the ore to the coast. The survey for a single track, 360-mile line, was begun in 1945, starting from the fishing village of Sept Iles on the Gulf of St Lawrence and extending to Knob Lake. Topographically, construction of the railway was in three sections: a short 20-mile stretch over the coastal sand plains; 130 miles through the extremely rugged country of the edge of the interior plateau, in which the railway climbs nearly 2000 ft. along the valleys of the Moisie, Nipissis and Wacouno rivers until, at mile 150, it comes out on to the

flat plateau; and a third section of 110 miles, in which the main construction obstacles are large shallow lakes. The railway was laid out in independent sections with men and equipment brought in by air to fourteen landing strips prepared along the right of way. It was completed in February 1954 and the first ore was moved out that summer. Production from the open pits rose rapidly from 2 million tons in the first year to 13 million tons of ore in 1957. The company forecasts a production of 9 to 10 million tons in 1958 because of reduced demand from the United States market. The maximum production was intended to be about 20 million tons which is the capacity of the railway under present operating conditions. However, there are indications that this will be increased by expanding the ore handling facilities at Sept Iles when there is a demand for larger quantities of iron ore.

Ore is mined for 7 months of the year; during this period sufficient ore is shipped to Sept Iles to build up stock piles large enough to supply ore carriers for about 9 months of the year. The ore is hauled out from the interior by diesel-electric locomotives, normally with five units to a train of about 130 cars stretching for over a mile. From Sept Iles the ore is shipped to Atlantic ports in the United States and to Contrecoeur near Montreal whence it is moved inland by rail, at least until the St Lawrence Seaway is completed in 1959, and to Europe. Plans for keeping Sept Iles, and the other ports on the north shore of the Gulf of St Lawrence, open during the winter with the help of an ice-breaker and aerial ice patrols are at present under investigation.

It was not originally planned to keep the railway open in the winter, but it proved cheaper to do this than to reopen in the spring; other traffic, partly of a military character, also became available to compensate for the period when ore is not carried. The main reason that ore is not shipped in winter is that it freezes in transit and cannot be removed from the freight cars at Sept Iles. A number of remedies have been suggested, but a satisfactory solution may have to await the pelletization of the ores. During the winter, work continues in the pits, but is limited to levelling, removing overburden and opening them up for operations in the following summer. Permafrost is present in one of the pits, and has led to certain problems with the size of explosive charges used, and the weight of the blocks that are broken up.

The first company settlement in the iron ore area was at Burnt Creek, but when it was discovered to be underlain by an ore body the settlement was moved to the present site northeast of Knob Lake, after which it was at first named; it has subsequently been renamed Schefferville.* The present population is about 3000 in the summer and 1600 in the winter. With the exception of some military and research personnel, virtually the whole European population is directly or indirectly dependent upon the Iron Ore and related companies. Four hundred family housing units exist for company employees, but the turnover of personnel, particularly in the bunkhouses which house the remainder of the population, is high.[5, 6]

Although the Knob Lake area is the only mineral-producing area at present, similar geological formations with known mineral occurrences are found else-

* The name Knob Lake continues to be used for the airport.

where in the Labrador trough. Two regions have attracted attention. At the south end of the trough several mining companies have been exploring in the vicinity of Wabush Lake where there are large deposits of low-grade iron ore. A 40-mile spur line from the Quebec North Shore and Labrador Railway at mile 224 (from Sept Iles) is under construction to develop these ores. West of this area, also at the south end of the trough, a second railway into sub-Arctic Quebec is being built by the Cartier Railway Company to develop low-grade iron ore deposits owned by Quebec Cartier Mining Company, a subsidiary of the United States Steel Company. The railway will extend from Shelter Bay, a new port on the Gulf of St Lawrence, initially to Mount Reed and eventually to Mount Wright. The first production is expected to be 6 million tons of concentrate a year, beginning in 1961. Unlike the Quebec North Shore and Labrador Railway the Cartier Railway is not a common carrier, but agreement may be reached to ship part of the nearby Wabush Lake ores by this route.

The original charter to the Quebec North Shore and Labrador Railway allowed for the continuation of the railway north from Knob Lake, roughly along the Labrador trough to Ungava Bay. There are no indications that the railway will be extended in the near future, except locally near Knob Lake, but considerable exploration has been undertaken at the north end of the Labrador trough on the west side of Ungava Bay. Low-grade iron ores have been discovered within a few miles of the sea in this area. In the last 2 years drilling has proved three large ore bodies near Leaf Bay, Hopes Advance Bay and Payne Bay—all wholly within the barren grounds. The low grade of the deposits, the highest tides in the world together with extremely shallow water, and the ice conditions of Ungava Bay have retarded development. In spite of a similar early optimism following mineral discoveries in an area of Proterozoic rocks geologically related to the Labrador trough, between Wakeham Bay and Cape Smith on Hudson Bay, the exploratory phase is not complete and production in the near future is unlikely. The search in this area has been for nickel and other base metals. An air strip was constructed in the centre of this northern belt at Esker Lake in 1957 and there was widespread drilling and prospecting; results on the whole have been disappointing.

Other mineral developments in the Labrador–Quebec peninsula are still in the planning and surveying stages. Mining exploration teams have been working on the Hudson Bay coast, notably around Great Whale River, on the Belcher Islands and east of Fort George. Iron ore has been found in all areas and extensive drilling is being undertaken at Great Whale River, 37 miles inland from the bay.

There has also been widespread mining exploration on the Labrador coast, particularly by the British Newfoundland Corporation. Perhaps of greatest interest is the survey by this company of Grand Falls on the Hamilton River with the object of developing the hydro-electric potential of the falls. To reach the falls a road has been built from the Quebec North Shore and Labrador Railway.

Although the Knob Lake area is the only producing region today a number of generalizations can be made about the course of developments. In the early

stages aircraft are all-important; the initial prospecting may be from the air, the prospecting crews will have their own aircraft and if the exploratory drilling stage is reached, airstrips for larger aircraft will be constructed and the necessary equipment flown in. For the actual exploitation of ores in northern areas it is clear that immense capital outlay is required for railways, ports and towns and that only the largest companies are capable of obtaining it.

One other aspect of the post-war changes in Labrador–Quebec should be noted. This is the building of the eastern part of the "Mid-Canada" radar warning system, roughly along the 55° N. parallel that runs through Great Whale River and Knob Lake to the Labrador coast. Although relatively few men are required to operate the system now that it is built, the construction phase brought many companies into the north and led to the creation of new airfields. A majority of the stations were built entirely from materials flown in to the sites and are now serviced by aircraft. The establishment of radar systems in the north has led to major improvements in the military communication system and a secondary result has been the north-eastern extension of the continental telephone system by microwave radio using tropospheric scatter from Sept Iles to Goose Bay.

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IRON ORE IN ARCTIC EUROPE

BY P. A. B. GETHIN

[*MS. received 1 August 1958.*]

CONTENTS

Introduction . . . *page* 314
Swedish Lapland . . . 314
Norway . . . . . *page* 318
U.S.S.R. 318

Introduction

Iron ore in significant quantities has been found in only four areas in arctic Europe. No deposits are known in arctic Asia or in the arctic islands of the eastern hemisphere. The largest iron-bearing area is in Swedish Lapland of which the total known reserves, mainly magnetite and hematite, are estimated at 2413 million metric tons,* with an average iron content of over 63 per cent,[1] or a ferric weight of about 1532 million tons.[2] The greater part of this ore requires no concentration before use. There is a deposit of about 1000 million tons in Sør-Varanger in north Norway, with a low iron content,[1] while the deposit at Yena in Kol'skiy Poluostrov (Kola peninsula) is estimated at nearly 850 million tons of ore with an iron content of 23 to 48 per cent,[3] and like the Varanger ore requires concentration.[1] A deposit with an iron content of 30 to 40 per cent has been investigated recently at Kolari in north-west Finland, but it is not yet worked.

Swedish Lapland

The ore mountain Kiirunavaara at Kiruna is probably the world's largest single iron ore body. When mining began, Kiirunavaara rose over 200 m. above the level of the neighbouring lake, Luossajärvi, and 747 m. above sea level; the mountain ridge has now been broken away, terraced, and cleft by a huge wedge almost down to the lake level by the open-cast operations. The depth of the deposit is unknown, but magnetic measurements made from the air indicate a depth of at least 1700 m. The horizontal area of the ore zone is about 325,000 sq.m. at the level of the foot of the mountain. An estimate based on a depth of only 1000 m. from that level puts the reserves of the deposits at 1600 million tons. The ore is classified into grades, ranging from 60 to 68 per cent iron content, and with a phosphorus content of 2 per cent to less than 0·03 per cent.[2]

Luossavaara, the mountain on the north-east side of Luossajärvi, contains another deposit, geologically connected with Kiirunavaara although far

* All measurements in this article are given in metric tons.

Iron mine workings at Kiirunavaara from across the lake Luossajärvi

Photograph by courtesy of Luossavaara–Kiirunavaara–Aktiebolag

Geodetic survey of northern Canada. Ski-wheel "Dakota", and "Jamesway" hut partially assembled.

smaller. The deposits of Rektorn and Nokutusvaara, both with a high phosphorus content, and Tuolluvaara, with a low phosphorus content, also lie within 10 km. of Kiruna. The reserves of these four are about 40 million tons.[2]

Second in size among Lapland ore fields is the Gällivare group. The main deposit here is Malmberget, with an ore area of about 177,000 sq.m., and an estimated reserve of some 410 million tons. The average content of iron is 62 per cent, and of phosphorus 0·8 per cent.[2] The small neighbouring deposit of Koskullskulle is estimated at about 10 million tons and is particularly valuable for its very low phosphorus content.[4]

There are also important deposits at Ekströmsberg, estimated at 25 million tons with a fairly high phosphorus content; at Mertainen, estimated at 50 million tons of high iron and low phosphorus content; at Svappavaara, put at 45 million tons of ore, with a fairly high phosphorus content; and at Leveäniemi, estimated at 30 million tons, poor in phosphorus.[2] These deposits are being treated as reserves. Their total resources have been estimated at 150 million tons though their depth has not been fully investigated. Together they cover an area of at least 230,000 sq.m.[5]

All these deposits are known as apatite iron ores of Kiruna type, and, with the exception of the Gällivare group, lie within 50 km. of Kiruna. But there are also several occurrences in Swedish Lapland of skarn and sedimentary quartzose iron ores. Unlike most of the Kiruna type ores they have a low phosphorus content but usually a high sulphur content, often around 5 per cent. The biggest are at Kaunisvaara, Masungsbyn, Kallak, Salmivaara, Lannavaara, Pellivuoma, Marjarova, Vittangi and Vieto. Their total area is nearly 400,000 sq.m., and their iron content varies from 35 to 60 per cent. Little is known about them, but reserves have been estimated at at least 195 million tons.[5]

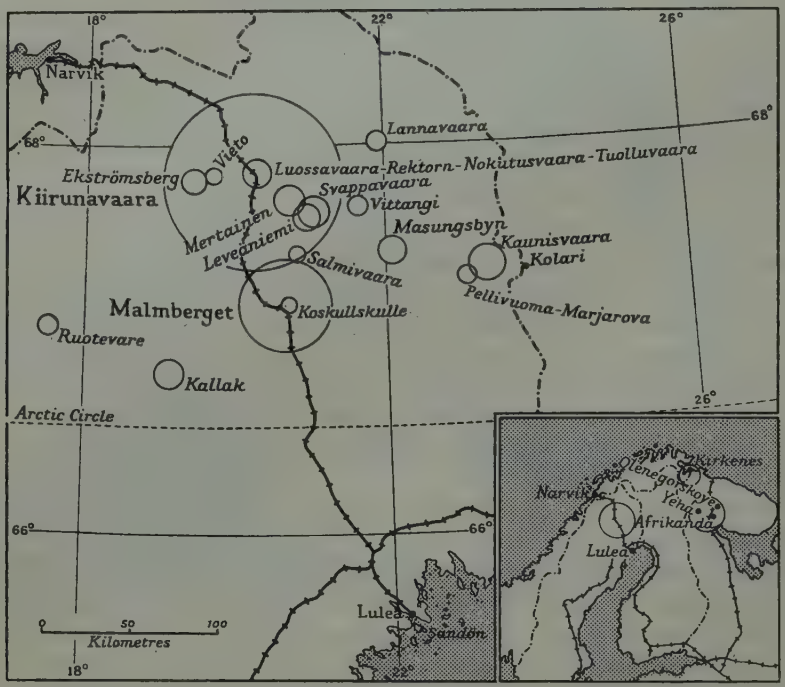
There is also an isolated occurrence of titaniferous iron ore at Ruotevare, near Kvikkjokk.[5]

Iron ore was first discovered in Swedish Lapland in the seventeenth century; Kiirunavaara and Malmberget were discovered around 1700. Early attempts to exploit the ores ended in costly failure, partly because of the difficulties of transport, and partly because there was then no known method of converting the phosphoric iron ores of Lapland into steel. It was not until 1878 that a satisfactory method of doing this was developed, by the English chemists Thomas and Gilchrist, and exploitation of the Lapland ores became an economic enterprise. British capital was attracted to Lapland, and in 1888 a railway between Gällivare and Luleå was opened, and the first cargo of ore was shipped. The British company which had built the railway failed, and the Swedish state took it over in 1891. It was continued, via Kiirunavaara and Luossavaara, to Narvik. It was completed in 1902, and the first ore ship sailed from Narvik at the beginning of 1903.

The distance by rail from Kiruna to Narvik is about 170 km., and from Gällivare to Luleå about 160 km. There are no steep gradients on the outward haulage in either direction. The stretch between Kiruna and Riksgränsen was electrified in 1914, and between Kiruna and Luleå in 1923. The ore is trans-

ported by trains composed of up to sixty-five ore trucks, weighing a total of 3100 tons and drawn by 5000 h.p. locomotives. About seventeen such trains a day leave Kiruna for Narvik, which is open all the year round, while all the Gällivare ore is taken out via Luleå, which is closed to traffic by ice for five months in the year. Narvik handles about two to three times as much ore as Luleå.

All the iron mines at Kiruna and Gällivare are now operated by Luossavaara–Kiirunavaara Aktiebolaget (LKAB). This company, founded in 1890, was purchased in 1903 by the mining and railway company of central Sweden, Trafikaktiebolaget Grängesberg–Oxelösund (TGO). In 1907 the Swedish state



Iron ore deposits in Swedish Lapland and (inset) in Arctic Europe. Area of circles is proportionate to estimated ore reserves.

obtained a half share in the enterprise, and finally, on 1 October 1957, LKAB was completely nationalized, except for a small parcel of shares retained by TGO.

Mining at Kiirunavaara, which now accounts for about 65 per cent of Lapland's annual production, began in about 1900, first in the open pit and later underground as well. It is planned to continue the open pit down to the level of the railway, just above the level of Luossajärvi. Power is obtained from the hydro-electric power station 100 km. to the south at Porjus. The quantities of ore extracted from Kiirunavaara have fluctuated greatly, but only once since 1904, in 1945, has output fallen below 1 million tons in a year. A great

increase has taken place since 1948. Luossavaara deposit was discovered at the same time as Kiirunavaara. Regular mining began in 1919 in an open pit, but the larger part of production now comes from underground workings. Up to 1948 average annual production was roughly 300,000 tons, but, as at Kiirunavaara, it has increased greatly since then. Some 2 million tons of ore have been extracted from the Rektor seam since mining started there in 1925; with its phosphorus content of over 4 per cent it was found useful during the Second World War for the production of phosphate fertilizers.

At Malmberget the ore lies in a number of separate deposits. The change from open pit to underground mining was made earlier there than at Kiruna. and since 1943 practically all mining has been underground. Annual production has not often fallen below 1 million tons since 1900, and has increased greatly since 1948. Koskullskulle was in Czech ownership until 1950, when it was bought by LKAB. Average production here has been about 300,000 tons a year until recently.

The only other iron ore mines being worked in Swedish Lapland at present are Mertainen and Tuolluvaara. Mertainen was discovered in 1897, and is owned by Norrbottens Järnverks AB (a State company). Experimental mining was started there in 1956. Tuolluvaara, also discovered in 1897, was first worked in 1902. It is owned by Tuolluvaara Gruv AB and before the Second World War annual production was about 100,000 tons of ore.

In 1913 the total quantity of iron ore extracted in Swedish Lapland was 4,913,603 tons.[6] In 1956, 14,094,745 tons of directly usable iron ore and 280,123 tons of concentrates were extracted. The figure for the directly usable ore production in 1956 was made up as follows:

	Metric tons
Kiirunavaara	9,409,525
Malmberget	2,748,623
Luossavaara	933,827
Koskullskulle	564,407
Tuolluvaara	387,320
Mertainen	51,043[7]

Nine-tenths of the concentrates came from the Gällivare deposits.[7] The Swedish Lapland iron ores account for 4 to 5 per cent of total world production, and when measured by ferric content the proportion is somewhat greater.

Since 1951 LKAB has been engaged on a big expansion and rationalization programme. The new haulage and dressing plant at Kiruna is the largest in the world and has a capacity of 4000 tons an hour. The transition to underground mining and the increase in output has required much new plant and a larger labour force. LKAB already owns 1500 dwellings occupied by its employees in the town of Kiruna. The company's ore storage and loading installations in Narvik have been enlarged and have a crushing and loading capacity of 4000 tons of ore an hour. New workshops, transport equipment, underground plant and sorting machinery are also being constructed at Malmberget, and a new ore port is planned at Sandön outside Luleå. Between 1952 and 1957 this investment programme has cost about 550 million kroner (approx.

£38 million). The degree of rationalization achieved is indicated by the fact that in 1928, 4760 employees produced 3·5 million tons, while in 1956 some 7500 produced 13·9 million tons.

Norway

The main Sør-Varanger deposit occurs at Bjørnevatn, about 9 km. south of Kirkenes, and at a height of about 150 m. above sea level. The Soviet frontier here lies less than 3 km. to the east. The ore zone forms a V pointing northwards. It consists of a taconite of very hard magnetite interlaminated with quartz, and a typical specimen has a 34 to 37 per cent iron content. The phosphorus and sulphur content is low.[8]

The deposit was discovered in the late 1860's and in 1906 the mining company Aktieselskabet Sydvaranger was formed to work it. The building of harbour installations, a concentrator, and other plant started at Kirkenes in 1907 and the first shipment of concentrate was made in 1910. In the early years of the First World War production was about 550,000 metric tons of concentrates a year, and in 1937 it had reached 700,000 tons. During the Second World War Kirkenes and the mining plant were destroyed, first by Allied bombardment and later by the retreating Germans. After the war, foreign demand and the subscription of about 60 per cent of the necessary capital by the Norwegian government made it possible to undertake reconstruction of the shattered enterprise. Improved mining methods were developed and new processing plant and port installations were built.

The mining and processing of the unusually hard Bjørnevatn ore presents many difficulties. It is still extracted by open-cast methods, crushed by one of the world's heaviest crushers and transported by electric railway to the plant at Kirkenes. Here it is turned into concentrates in the form of a fine black powder of about 65 per cent iron content. An increasing proportion of this is made into pellets suitable for blast furnaces. Power for all these operations is obtained chiefly from a steam turbine plant in Kirkenes which uses Svalbard coal, although some power is available from small hydro-electric plants in the region.[8] Production began again in 1952. In that year 413,554 tons of concentrates were produced. This very first year of renewed operations made Sør-Varanger once more by far the largest iron mine in Norway. In 1956 a labour force of 796 produced 1,119,819 tons of concentrate.[9] Kirkenes is not connected to the main rail network, and the road to the south is blocked in winter. The port, however, is open all the year round.

U.S.S.R.

There have been experiments in exploiting the iron ore deposits at Yena for use at the new steel works at Cherepovets, near Vologda, but this has proved uneconomical, and the plans are apparently not to be put into effect yet.[10]

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According to information received since going to press, iron deposits at Olenegorskoye and Afrikanda contain 442 and 626 million tons ferric weight respectively; the ferric weight of the Yena deposit is said to be 393 million tons. Ore from Olenegorskoye is being used at Cherepovets. (I. P. Bardin, ed., *Zhelezorudnaya baza chernoy metallurgii SSSR*. Moscow, 1957, p. 79–88.)

GEODETIC SURVEY OF NORTHERN CANADA BY SHORAN TRILATERATION

BY ANGUS C. HAMILTON*

[*MS. received 15 July 1958.*]

CONTENTS

Introduction	*page* 320	Aircraft	*page* 326
Method of measurement	320	Navigation	328
Accuracy of measurements	321	Radio communications	328
Field operations	322	Ground stations	329
Weather	324	Results	329
Personnel	325		

Introduction

A geodetic survey by shoran trilateration, to approximately second-order accuracy, of the islands of the Canadian Arctic archipelago was completed in 1957. This was the culmination of a programme started in the south-central section of the country in 1949.

Method of measurement

Shoran (short-range aid to navigation) was developed during World War II as a navigational aid for precise tactical bombing. It consists of two radar transponders at known points on the ground and another radar unit in an aircraft capable of measuring the time required for radio waves to travel from the aircraft to each ground station and to return. These times are converted to distances by an intricate electro-mechanical system and the distances are shown on counters, reading to 0·001 mile. For the military application the distance between transponders was known and the position of the aircraft could be plotted from the mileage-counter distances; for geodetic application the mileage-counter distances are used to measure the distance between the two transponders. As the aircraft flies across the line joining the two ground units the sum of the mileage-counter distances decreases, reaching a minimum when the aircraft is directly above this line. This distance sum, along with other data such as height of the aircraft and velocity of propagation, enables geodetic engineers to compute the spheroidal distance between the two transponder units. Using lengths measured in this way it is possible to build up a trilateration network from which the geographical co-ordinates of each point can be computed (see Fig. 1).

* Geodetic Survey of Canada.

Fig. 1. Area covered by shoran trilateration of northern Canada. Annual coverage denoted by dates and dark lines.

Accuracy of measurements

The pulse method of measurement has definite limitations in achievable accuracy. Measurements made with converted military equipment indicated a random error of about 25 ft. and even with units specially redesigned for survey there is still an error of about 15 ft. These errors are virtually independent of the length of the line measured so that while a long line, say 300 miles, may be measured with quite high relative accuracy, 1:75,000, in a short line the standard of accuracy is poor.

There are also systematic errors arising, in part at least, from difficulties in calibrating the equipment. In general, however, errors can be removed by a least squares adjustment of a network subject to external conditions. Meteorological and other errors are reduced by taking sets of measurements on two days; eight good measurements, called transits, are required for each set.

One hundred and nineteen stations were fixed by measuring 501 lines in this way. Analysis of the adjusted networks indicates that, on the average, lines are measured to an accuracy of 1:56,000. There is no rigorous method of assessing the accuracy of the computed station co-ordinates, but it is expected

that they will usually be within 150 ft. of their true position. Those stations adjacent to triangulation control will certainly be well within this figure, whereas those on the periphery of the network may be appreciably above it.

Field operations

A line of sight is necessary between the main unit in the aircraft and the transponders on the ground, since the shoran equipment operates in the very-high-frequency range (200–300 megacycles per second). To measure a distance of 300 miles both transponders must be above horizon level and the aircraft must be at an altitude of approximately 20,000 ft. (Fig. 2). Two parties are required on a shoran project—those who install and operate the transponders on the ground, and the crews who fly the aircraft on line-crossings. For the line-crossings an aircraft with an altitude capability of more than 20,000 ft., and an endurance of at least twelve hours, is necessary. The aircraft, in addition

Fig. 2. Shoran equipment, aircraft and transponders.

to the regular crew, carried a shoran navigator and two or three shoran operators. It requires a good runway and servicing facilities so that frequently the base may be several hundred miles from the working area. The airborne unit is independent of the terrain in the working area, and the major problem in the field is selection of a suitable base air field. On the other hand, the ground staff are dependent on conditions in the working area. A ground station equipped with a month's rations for three men and fuel supply weighs three to four tons, and installing these units at the top of suitable hills presents major problems. Every known means of transport in Canada was utilized at one time or another—flying boats, float planes, ski-wheel aircraft, helicopters, trucks, tractors, bulldozers, trains, schooners, canoes, horses, dog teams, toboggans, Indian packers and Eskimo packers. In spite of all this assistance at nearly every station the installation crew did a good share of back-packing.

A large organization is needed to operate efficiently. The optimum size of the group varies, but for most projects it has been found that ten or twelve ground stations and at least two line-crossing aircraft, preferably three, are needed for a smooth operation. It is obviously most efficient to measure all the lines radiating from a ground station without removing the equipment or personnel from the site. Thus, for Cambridge Bay (station 118 on the map) it was necessary to have installations at eight other stations—45, 115, 117, 119, 122, 124, 125 and 53—before Cambridge Bay could be completed. To complete station 119, immediately north of Cambridge Bay, these nine plus

Summary of shoran operations, 1949–57

Field seasons			Bases		Aircraft										Stations No. occupied[3]	Lines No. measured
					"Lancaster"		"Canso"		"Norseman"		"Dakota"		"Otter"			
Year	From	To	Main	Secondary	No.	Hr.[5]	No.	Hr.	No.	Hr.	No.	Hr.	No.	Hr.		
1949	16 May	6 Oct.	Winnipeg	The Pas	2	581	1	290	1	315	—	—	—	—	10	28
1950	5 June	13 Sept.	The Pas	—	2	589	1	398	1	238	—	—	—	—	19	56
1951	1 June	31 Aug.	Yellowknife	Norman Wells	2	694	2	663	2	384	—	—	—	—	26	65
1952[1]	15 June	27 Sept.	Yellowknife	—	2	823	4	1248	3	526	—	—	—	—	27	75
			Churchill	—	—	—	—	—	—	—	—	—	—	—	—	—
			Ottawa	Goose Bay	—	—	—	—	—	—	—	—	—	—	—	—
1953[1]	8 June	15 Oct.	Frobisher Bay	Fort Chimo	3	1200[4]	5	1900[4]	—	—	—	—	2	315[4]	35	101
				Fort William	—	—	—	—	—	—	—	—	—	—	—	—
1954[2]	29 Apr.	15 Aug.	Goose Bay	Knob Lake	4	513	6	700	—	—	1	38	3	312	13	26
1955	22 May	28 Aug.	Whitehorse	Norman Wells	3	875	3	800[4]	—	—	2	300[4]	2	100[4]	24	71
1956	1 May	30 July	Churchill	Cambridge Bay	4	740	1	235	—	—	6	1264	1	19	20	57
				Foxe	—	—	—	—	—	—	—	—	—	—	—	—
1957	5 Apr.	29 May	Thule	Resolute Bay	4	731	—	—	—	—	6	858	—	—	17	61

[1] In 1952 and 1953, after the conclusion of northern operations at the end of August, smaller networks further south were undertaken. In each case figures for the entire season are listed.

[2] In 1954, 7841 line miles of shoran controlled photography were flown. Line-crossing operations were limited to those necessary to fix the additional stations required for the controlled photography.

[3] Total occupied exceeds total in net since several stations were occupied on two or more years.

[4] Estimated.

[5] Hr = Total duration of flights in hours.

three more—120, 121, and 123—were needed. Even by transferring equipment from a completed site forward to a new site it follows that a large complement of equipment is essential.

The map (Fig. 1) shows the area covered each year and the table lists the bases used, types of aircraft, number of stations and lines.

Weather

All planning of arctic operations revolves around weather. For most projects the winter period of darkness and extreme cold is unsuitable. This leaves approximately six months from March to September during the arctic spring and summer. South of Lancaster Sound (lat. 75° N.) the ice in most of the lakes clears by early August. Ice in the channels between the islands drifts in packs leaving areas of open water whose location depends on the prevailing wind. Thus any site on the coast might be open for twenty-four hours, for six weeks, or not at all. To install, maintain, and remove a shoran station requires assured access to the site during a six-week period. Flying boats have operated in this area on magnetic and astronomical surveys, but programmes for these projects were revised daily subject to weather and open water; they had wide freedom in choice of sites and they visited each site only once. The relatively rigid site requirements for the shoran network ruled out a summer operation involving coastal sites.

During most of August fog from open water in the channels limits low altitude visual flight rule (VFR) flying to roughly one day out of four. In these circumstances planning or scheduling is impossible. Some points may not have clear weather for weeks at a time. In 1955 we planned a small net on Banks Island and Victoria Island. One station was to be at Banks (120) near the north end of Banks Island. The equipment was assembled on an airstrip at Clinton Point (114). A "Canso" crew deposited one load of equipment at the site, but before they could get back with the second load and the personnel the weather had closed in, and they waited some ten days to complete the installation. By this time it was clear that the station could not be successfully occupied and the "Canso" crew were ordered to retrieve the load of equipment from the site. They had to wait another week for suitable weather to get the equipment back. This may have been an extreme case, but it illustrates the difficulties of working by aircraft during the arctic summer.

During late June and July, break-up is in progress and landing at unprepared airports is impossible. This leaves April, May and early June and fortunately this period has no serious drawbacks. The weather is mostly clear, there is continuous daylight, temperatures are relatively moderate, −20° to +40° F. (−29° to 4·5° C.), and landing conditions on the snow or ice are generally good. Even in this period there is one problem which recurs frequently and may cause serious delay. This is blowing snow, designated "B.S." on meteorological charts.

Unless the snow is close to melting any wind over ten knots picks up the

fine crystals and carries them along, often only a few inches from the ground. For men working on the ground this presents no serious obstacle, but for a pilot wishing to land on an uncharted lake or snowfield it can obscure or blur surface details so that landing becomes impossible. In May 1956 this condition prevailed at Banks (120) for several days. The station was operating, but required a resupply of fuel and rations. Several times the station reported clear weather, but by the time the aircraft flew from Cambridge Bay to Banks the wind had increased and the station was obscured.

Occasionally ice crystal fog caused a whiteout condition in which nearby objects were quite visible but sky and snow blended to obliterate the horizon. This also precluded safe landings or take-offs. Nevertheless, on the whole the weather is favourable, and April, May and early June are by far the best time of year to operate in the region.

Personnel

A nucleus of R.C.A.F. technical personnel and geodetic engineers was employed full time on the project. During the winter they were involved in planning, training and logistics, and during the summer their number was augmented by the air crew and maintenance personnel necessary to support the operation, but whose duties did not call for special training in connection with it.

The total number of personnel increased from some 75 in 1949 to 280 in 1957. All but ten of these were members of 408 (P) Squadron, R.C.A.F. A classification of personnel in 1957 is listed below.

Officers:		
3 "Lancaster" crews	15	
7 "Dakota" crews	28	
Supervisory and technical	7	
Civilian, geodetic (including one meteorologist)	10	
	—	60
Airmen and N.C.O.'s:		
Aircraft maintenance		132
Shoran and communications		88
	Total	280

Air crews changed regularly after three years on the project; ground crews and technical personnel changed irregularly but averaged the same rate. It is estimated that more than 1000 R.C.A.F. personnel participated in the project at one time or another.

Officers commanding the R.C.A.F. detachment were: Fl./Lt. K. W. MacDonald (1949, 1950), Sq.-Ldr. W. A. R. Barry (1951), Sq.-Ldr. P. J. Presidente (1952, 1953), Wing-Com. J. G. Showler (1954, 1957), Sq.-Ldr. K. W. Brown (1955), and Sq.-Ldr. A. A. Lehn (1956).

Shoran and communications personnel and equipment were under the direction of the telecommunications officers. These were: Fl./Lt. L. C. Card

(1949), Fl./Lt. W. Smalluk (1950, 1951), Fl./Lt. W. White (1952, 1953), F/O D. W. Bassom (1954, 1955), F/O J. R. Marchand (1955, 1956), Fl./Lt. D. E. Smith (1956, 1957), and Sq.-Ldr. O. F. Bradley (1954–57).

Computations and adjustments were carried out by Geodetic Survey personnel at the main field base to ensure that each line was measured with satisfactory accuracy before the ground stations were withdrawn. J. E. R. Ross, Dominion Geodesist, 1951–57, initiated the project, supervised the field office personally for the first season, and continued to give general supervision until the network was completed. Many graduate and student engineers worked in the field office on a seasonal or temporary basis. Continuity was maintained and supervision provided by a few members of the Geodetic Survey permanent staff; W. J. MacLean (1949–54), S. A. Yaskowich (1949–57), A. C. Hamilton (1949–57), and C. D. McLellan (1951–57).

Aircraft

Line-crossing. Converted World War II "Lancaster" bombers were used for all line-crossings. They were not ideal for the purpose, but they had the altitude capability and endurance for the job and they were readily available at the time shoran was starting. Transits were flown at altitudes from 8000 to 26,000 ft. with the majority being done in the 16,000 to 20,000 ft. range. More aircraft time was consumed in getting from base to working area and return than in actual line flying. Even with the use of a forward base there was still much time lost. For example, in 1956 it took about six hours to get from Churchill to Cambridge Bay, and after refuelling there it took two or three hours to get to the lines in the area of station Banks (120). After allowing for sufficient fuel to get to an alternate airport, only about three hours were available in the working area. Since no hangar was available at Cambridge Bay, aircraft could not remain there more than two or three days before returning for maintenance, which could only be done in the hangar at Churchill.

Water landing. South of the Arctic coast summer operations had been possible. On all the mainland, and on the southern section of Baffin Island, lakes are sure to be open for six weeks and are likely to be open for two months or more. Since shoran operations require a network of stations to be in position simultaneously for several weeks, six weeks is the shortest period that can be utilized. For summer operations the "Canso" flying-boat was used for transport to uncharted lakes, supported by single-engine float aircraft, such as the "Norsemen" or "Otter", and by "Dakota" wherever airstrips were available.

Ski-landing. Both the twin-engined "Dakota" and the single-engined "Otter" can be readily converted to ski-wheel aircraft. In 1954 three stations in Labrador were installed by these aircraft, but it was not until 1956 that ski operations were undertaken on a large scale. Our experience at Banks had convinced us that summer operations in the Arctic islands were futile. For the 1956 network, sites were selected the previous summer adjacent to lakes. This had a dual purpose; it ensured that there would be a level area near the

site for a ski landing with the "Dakotas", and that the station could be withdrawn by "Canso" later in the summer if the ice broke up before the line-crossings were completed. Installations were started in May and ski operations continued until the end of June.

There was little information available on the type of snow conditions that would be encountered. Ski landings had been made in the region previously in emergencies, but this was the first large project fully dependent on ski landings at unprepared sites. There were several surprises—some pleasant, others disappointing. Station No. 121 on Melville Island had been installed by landing on the sea ice in Bridport Inlet. By mid-June lines from the station were completed; there were no obvious signs of spring, yet the ice in the inlet had buckled to such an extent that it was far too rough for a safe landing. Supplies were dropped by parachute and it was not until 28 July that there was a channel of open water wide enough for a "Canso" to land and pick up the personnel. On the other hand, at Pond Inlet (129) the sea ice rose and fell with the tide and even though there had been considerable melting it was possible to land safely on 25 June. At Gillian (84) in mid-June the snow was beginning to melt and the aircraft bogged down in the snow to such an extent that full power was needed to taxi an empty aircraft. This caused the engines to overheat and, to prevent damage to the engines, it was necessary to discontinue ski operations at this site. Stations 122 and 124 were both on fresh water lakes several miles in diameter. In mid-June there were several days of continuous sunshine in which most of the snow on the land disappeared. The snow on top of the lakes turned to slush and ski operations were cancelled. The ice on the lake was still several feet thick and, under the influence of the water from the melting snow pouring down the banks, the ice melted at the edge and buoyed up free from the shore. The surface water and slush drained to the edges, or through cracks, leaving a relatively even surface. Near midnight, when the sun was low, the temperature fell below freezing and for a few days the floating ice was again safe for landing. At station 122 on Prince of Wales Island, the personnel were removed from the station at this time, although they had to use the aircraft's rubber dinghy to cross the open water between the shore and the floating ice mass.

The ski-equipped aircraft proved to be more versatile than the float aircraft; with good snow conditions it was frequently possible to taxi up the hill directly to the site and save back-packing. It was indeed a strange sight to see an aircraft come over the brow of a hill with a roar and a flurry of snow. At some sites after careful reconnaissance it was possible to land on a smooth plateau at the station elevation. The only serious problem was damage to skis. The snow was extremely hard, snowshoes were never necessary, and in drifts one to two feet high and some ten to fifteen feet apart, this was a good fraction of the length of the ski and there was much "slapping" with consequent damage. Most of the damage was minor, but it did necessitate service on the average after every five landings.

North of Lancaster Sound there are very few large lakes, so the operation was planned for both installation and removal to be done by the ski-equipped

aircraft. Installations were started early in April and the stations were all removed by the end of May, before melting or sticky snow conditions became a problem. In 1957 two stations were installed on snowfields on Ellesmere Island. On the surface of the snowfield the new snow was soft and there was no damage to skis. There was the risk of much more serious damage that could result from crevasses, but fortunately this did not occur.

Helicopters. These aircraft proved to have too short a range and too small a payload to be as useful as might have been expected in operations of this nature. They were used on a few occasions for jobs that no other aircraft could do, but they required a large amount of support from fixed wing aircraft.

In the Yukon one was used to lift a station to the top of a mountain near Chapman Lake (107), and in the summer of 1956 another was used on the installation at Gillian (84) and to withdraw personnel from several stations during breakup. In all of these operations fixed wing aircraft flew more hours in support of the helicopter than they would have flown if they could have done the job without it.

Navigation

In 1956 the North Magnetic Pole was roughly in the centre of the working area. This precluded any use whatever being made of the magnetic compass. Most navigation was by gyro compass, each aircraft having at least two. All aircraft carried at least one navigator trained in astro navigation. In addition, each aircraft was fitted with two radio compasses to home on any of the few radio ranges available. No aircraft were lost although several crews had difficulty regaining orientation after searching for a ground station during whiteout conditions.

Radio communications

Good radio contact between bases, aircraft, and ground stations is essential if delays, misunderstanding, and confusion are to be avoided. The shoran operator in the aircraft must be able to pass instructions to both the ground stations he is using; all aircraft must be able to pass their position and plans to base half hourly; ground stations must report meteorological observations to base periodically; and, in addition, there are numerous other queries and requests that made an efficient radio network indispensable.

Transmitters putting out 250 watts were maintained at all base camps and operated continuously except when no aircraft were flying. Each ground station was equipped with a 50-watt aircraft-type transmitter-receiver. On arctic operations each ground station had one qualified radio operator, so that code could be sent when conditions were unsatisfactory for voice reception. The main frequency used was 6693 kc./sec. and was quite satisfactory. Alternate frequencies of 5688 and 8967 were used periodically. Except during periods of extreme auroral activity good communications were maintained.

Ground stations

"Jamesway" huts were used on all winter operations. Their dimensions are 10 by 16 ft. and they can be joined end to end. This type of shelter may seem luxurious to hardy explorers of the old school, but there are very good reasons for using it. The equipment must be kept dry and reasonably warm during operation; repairs may be required quickly and no technician can work effectively in physical discomfort; when good flying conditions prevailed ground stations were required to be on the air as much as twenty hours daily. It takes a year of formal training and at least a year of practical experience to train a technician adequately. Consequently, it is much easier to provide comfortable quarters for good technicians than it is to make good technicians out of survival experts.

One "Jamesway" was used for sleeping, cooking and for the communications equipment and another one was provided for the shoran units. In addition, a survival kit was cached in a small tent nearby in case of emergency.

All ground stations were provided with propane heaters. Difficulty was experienced in getting the propane to flow out of the containers at low temperatures, for as the propane expanded at the neck of the bottle it tended to freeze and choke itself off. It was finally necessary to keep the bottles inside to ensure a continuous supply. Propane, with its heavy, expensive containers, seems to be an inefficient method of supplying heat to isolated arctic camps, but it was used because of its safety features. No stove pipes are necessary and there is virtually complete combustion so that there is no appreciable danger of men being overcome by fumes. The gas has a repulsive odour and at worst will cause nausea. Igniting the stoves can be a hazard if too much gas is allowed to escape. The greatest damage was caused by inexperienced men coming into a tent wearing full winter clothing and inadvertently standing so close to the stoves that their outer clothing got scorched. On the whole the propane stoves were successful and no losses were caused by them.

During the first few years of the project many small motor-generator units were tried with varying degrees of success. By the time arctic operations got under way an auxiliary power unit designed for use in aircraft had proved to be most suitable. This one, "Homelite" Model 24D28, has a rating of 87·5 amperes at 24 volts and weighs only 130 lb. Under subzero conditions fine blowing snow tended to choke off the carburettor air intake leading first to an improper gas mixture and finally choking the engine entirely. Various ingenious solutions were improvised, but snow walls built around three sides of the chargers and covered with a tarpaulin gave the best results.

Results

This trilateration has provided a skeleton of horizontal control for an area of some $2\frac{1}{2}$ million square miles. Already about 750,000 square miles of this area have been covered by shoran-controlled photography. This includes most of the area shown as "1951" on the map (p. 321) and a strip running east

from there to include part of the "1952" section and part of the "1956" section. This work has been done for the Army Survey Establishment by private contractors. The section shown as "1954" was done by the R.C.A.F. In addition some 270,000 square miles have been broken down by tellurometer and conventional topographic survey methods to control large-scale mapping.

Reconnaissance maps of the islands had been controlled by a few hasty sun observations, yet most of our co-ordinates differed by less than a mile from the map values. The largest discrepancy, about three miles, occurred on Prince of Wales Island, the locale of the North Magnetic Pole, where no astronomical observations had ever been recorded.

THE MANUSCRIPT COLLECTION OF THE SCOTT POLAR RESEARCH INSTITUTE

BY ANN SAVOURS

[*MS. received 1 July 1958.*]

CONTENTS

Introduction . . . *page* 331
Journals and correspondence . 331
Ships' logs . . . . *page* 334
Maps and survey data . . 334

Introduction

The Scott Polar Research Institute possesses a notable collection of manuscripts relating to the polar regions. An appeal through the Press in 1956 resulted in the acquisition of a number of interesting manuscripts which might otherwise have remained unnoticed in store, or been destroyed for want of storage space. The Institute is always anxious to increase its collection, and is grateful for the gift, or notice of the whereabouts, of any journals, log-books, letters and other material of polar interest. New accessions are listed in the annual report of the Scott Polar Research Institute, published in the *Polar Record* and the *Cambridge University Reporter*, and are summarized in the *Bulletin of the National Register of Archives* (London).

Journals and correspondence

The following is a list of the most important papers in the collection:

Back collection. The papers and journals of Sir George Back (1796–1878) have been on permanent loan to the Institute since 1955 from John Pares, Esq. They cover the period 1820–50, and consist of twenty bound notebooks and journals kept by Back during the Second Arctic Land Expedition, 1825–27; during the expedition in search of Sir John Ross, 1832–35, and during his travels in Europe. There are some 300 letters, mainly correspondence with the Admiralty concerning H.M.S. *Terror*, the loss of the *Erebus* and *Terror* and his own arctic expeditions.

Breitfuss collection. Among the library of published books collected by the late Dr Leonid L'vovich Breitfuss (1864–1950), the arctic historian, which were bought by the Scott Polar Research Institute in 1951, were some twenty unpublished papers and manuscripts written mostly in the 1920s by Dr Breitfuss and by Russian authorities, They consist mainly of short geographical descriptions of north-east Siberia.

W. S. Bruce collection. The papers and correspondence of the late William Spiers Bruce (1867–1921), the oceanographer and polar explorer, came to the Institute through his executors in 1946. The bulk of the collection consists of 397 letters written between 1893 and 1918 by Bruce and others interested or occupied in polar exploration. Besides the letters, there are typescripts of

documents relating to the early history of the South Shetland Islands, and parts of Bruce's own journal of the Scottish National Antarctic Expedition, 1902–04, with the printed but unpublished log of the *Scotia*.

R. T. Gould papers. The writings and polar correspondence of the late Rupert T. Gould (1890–1948), author of *Oddities* (1928) and *Enigmas* (1929), purchased from his executors in 1949. These papers deal with the early history of the Antarctic and the Franklin and Franklin Search expeditions in the Arctic.

Lefroy bequest. Papers, journals and correspondence of Sir John and Lady Franklin, and of their niece Sophia Cracroft, bequeathed in 1941 by the Misses Lefroy. The 165 journals of Lady Franklin cover most of her life; the earliest is a schoolgirl diary of 1803 and the latest her notes on a visit to Salt Lake City in 1870. Sir John's nineteen notebooks, letter books and journals relate mainly to his first and second Arctic Land Expeditions of 1819–22 and 1825–27, and to his naval service in the Mediterranean. There are over 1000 letters in the bequest. The collection also includes one of the last records of the Franklin Expedition, deposited by Lieut. Graham Gore, R.N., in a cairn on King William Island in May 1847, and discovered by Lieut. William R. Hobson, R.N., in 1859.

H. R. Mill gift; *H. R. Mill bequest.* The correspondence and unpublished papers of the late Hugh Robert Mill (1861–1950), Antarctic historian, which came to the Institute between 1946 and 1950. The "gift" consists of papers amassed by Mill while writing his *Life of Sir Ernest Shackleton* (London, 1923), and the "bequest" of over 300 letters from 136 correspondents.

Parry papers. Letters, diaries and correspondence of Sir William Edward Parry (1790–1855), presented in 1958 by Admiral Sir Edward Parry, K.C.B. There are fifteen bound notebooks and journals, 1030 letters, plus maps, papers and other material. There is, too, the original manuscript version of *The North Georgia Gazette and Winter Chronicle*, a newspaper produced during the voyage of the *Hecla* and *Griper*, 1819–20, and later published by John Murray, London, 1821.

Penny Craik gift. The correspondence of Captain William Penny, the Aberdeen whaling captain, who commanded the arctic search expedition of 1850–51, in *Lady Franklin* and *Sophia*, organized by Lady Franklin. The papers were presented in 1950 by Mrs Elizabeth Penny Craik. The period covered is roughly 1840–60. Some of the material concerns the Aberdeen whaling industry, but the bulk of it relates to the arctic voyage of 1850–51.

Papers of the Scottish Spitsbergen Syndicate (1909–51). Six foolscap volumes of papers (1381 sheets), mainly typewritten, relating to the affairs of the Syndicate, presented in 1956 by Group-Captain C. W. B. Urmston. There are additional maps and correspondence relating to the Syndicate in the R. N. Rudmose Brown bequest, 1957.

In addition to the above collections of papers there are a large number of journals, notebooks and logs kept during polar journeys of the nineteenth and twentieth centuries. The following is a list of the authors and the expeditions to which the papers refer:

Sir Francis Leopold McClintock, for the years 1848, 1850, 1852–54, 1858–59 (microfilm)

Robert Brown of Campster during the arctic voyage of S.S. *Narwhal* (Dundee), 1861; and during the British expedition to Greenland, 1867, leader Edward Whymper

Members of the British Arctic Expedition, 1875–76, leader Sir George Nares: Pelham Aldrich, G. le C. Egerton, G. A. Giffard, A. H. Markham, W. Rawson

Benjamin Leigh Smith and other members of his arctic expeditions of 1873–82

F. G. Jackson and members of the Jackson–Harmsworth Expedition to Zemlya Frantsa-Iosifa, 1894–97

Spitsbergen journals of E. J. Garwood, 1896–97

Journals and meteorological record kept by L. C. Bernacchi during the British Antarctic Expedition, 1898–1900, leader C. E. Borchgrevink

Members of the British National Antarctic Expedition, 1901–04, leader R. F. Scott: A. B. Armitage, M. Barne, L. C. Bernacchi, G. F. A. Mulock, G. R. M. Murray, Sir Charles Royds, R. F. Scott, Sir Reginald Skelton, E. A. Wilson

H. Darrell in the Canadian Arctic, 1899–1910

Members of the British Antarctic Expedition, 1907–09, leader Sir Ernest Shackleton: E. S. Marshall (microfilm), Sir Raymond Priestley, F. Wild (typescript copy). Also the meteorological log of the expedition, March 1908 to February 1909

Members of the British Antarctic (Terra Nova) Expedition, 1910–13, leader R. F. Scott: W. M. Bruce, V. L. A. Campbell, F. Debenham, H. L. L. Pennell, Sir Raymond Priestley, E. A. Wilson

Members of the British Imperial Trans-Antarctic Expedition, 1914–16, leader Sir Ernest Shackleton: R. W. James, F. A. Worsley, A. Keith Jack (abridged typescript copy)

R. N. Rudmose Brown in the Antarctic, 1902–04; in Spitsbergen, 1909–20

T. W. Bagshawe and M. C. Lester during the British Antarctic Expedition, 1920–22

D. G. Jeffrey and Sir Hubert Wilkins during the Shackleton-Rowett Expedition, 1920–22, leader Sir Ernest Shackleton

N. E. Odell during the Oxford University Expedition to Spitsbergen, 1921, and during the Merton College Arctic Expedition, 1923

Sir Hubert Wilkins during his arctic flight of 1928 (photo-copy)

Alfred Wegener during the German Greenland Expedition, 1930–31 (typescript copy)

Augustine Courtauld during the British arctic expeditions of 1926, 1929, 1930–31, 1935–36 (on permanent loan)

A. Stephenson during the British Arctic Air Route Expedition, 1930–31, leader H. G. Watkins, and the British Polar Year Expedition to Fort Rae, Canada, 1932–33, leader J. M. Stagg (typescript copies)

David Lack during the Cambridge Expedition to Bjørnøya, 1932, and during

the Cambridge Expedition to East Greenland and Iceland, 1933 (on permanent loan)

J. W. Wright during the Oxford University Arctic Expedition, 1935–36, leader A. R. Glen, and during the British Arctic Expedition, 1937–38, leader D. Haig-Thomas

Members of the British Graham Land Expedition, 1934–37, leader J. R. Rymill: G. C. L. Bertram, J. H. Martin, B. B. Roberts, A. Stephenson (typescript copy)

Sir Vivian Fuchs, Falkland Islands Dependencies Survey, 1947–50

Members of the Norwegian–British–Swedish Antarctic Expedition, 1949–52, leader J. Giæver: A. Reece, G. de Q. Robin, E. F. Roots, C. W. M. Swithinbank.

Ships' logs

Arctic

Alert, 1875; *Eira*, 1880, 1881–82; *Samson*, 1873.

Antarctic

Cora and *Robert*, 1820–21 (typed copy); *Grönland*, 1873–74 (microfilm); *Hersilia*, 1819–20 (microfilm); *Hero*, 1820–23 (microfilm); *Huntress*, 1820–22 (microfilm); *Morning*, 1902–03; *Penola*, 1934–37; *Penguin*, 1829–31 (microfilm); *Quest*, 1921–22 (typed copy); *Scotia*, 1902–04 (printed proof, never published); *Terra Nova*, 1910–13.

Maps and survey data

Arctic (listed by area)

Svalbard. Whalers' chart of Spitsbergen, 1815; unpublished maps by the Scottish Spitsbergen Syndicate, 1909–51; plane-table sheets and fair drawings of the Oxford University Arctic Expedition, 1935–36, leader A. R. Glen; plane-table sheets by W. Scott Moncrieff, Oxford University Expedition to Nordaustlandet, 1949, leader J. M. Hartog; two maps of Hopen by J. Neunteufl, German air operation "Helhus", 1944–45.

Soviet Arctic. Maps and charts drawn during or after the Waigatz Expedition, 1893, and the Jackson–Harmsworth Expedition to Zemlya Frantsa–Iosifa, 1894–97, leader F. G. Jackson.

Canadian Arctic and Greenland. Maps made by E. N. Kendall and others during the Second Arctic Land Expedition, 1825–27, leader Sir John Franklin (Lefroy bequest); plane-table sheets and fair drawings by J. W. Wright of the Smith Sound area, resulting from the British Arctic Expedition, 1937–38, leader D. Haig-Thomas; photocopies and blueprints of original maps made during or after the British Canadian Arctic Expedition, 1936–40.

Antarctic

Copies of early nineteenth-century charts of the Falkland Islands Dependencies by W. H. Goddard, E. Bransfield, G. Powell, R. Fildes and others.

Maps and survey data of the British Antarctic (Terra Nova) Expedition, 1910–13, leader R. F. Scott.

Maps and charts by M. C. Lester of the British Antarctic Expedition, 1920–22.

Plane-table sheets, fair drawings and survey data of the British Graham Land Expedition, 1934–37, leader J. R. Rymill.

Survey data of the South Georgia Surveys, 1951–57, leader V. D. Carse.

Plane-table sheet and survey data from the Gough Island Scientific Survey, 1955–56, leader J. Heaney.

FIELD WORK

BRITISH EXPEDITION TO VESTSPITSBERGEN, 1956

[By A. B. Erskine.]

A small private party, consisting of A. Davies, leader, R. G. Moffet, surveyor, and A. B. Erskine, assistant surveyor, spent five weeks in Vestspitsbergen in July and August 1956. They were consolidating and extending previous survey work of Cambridge parties in the area around the south end of Austfjorden. They landed by boat at Skottehytta, at the north end of Billefjorden, on 14 July, crossed over to Austfjorden via Ragnarbreen and Mittag-Lefflerbreen (man-hauling), and carried on their survey work in the mountains on both sides of the fjord. Finally, they did a short excursion to climb Newtontoppen and returned to Skottehytte via Lomonosovfonna and Ebbabreen.

FRENCH EXPEDITION TO CENTRAL GREENLAND, 1956–57

[Summarized from information from M. de Lannurien. An account of the establishment of the expedition station in lat. 71° 20′ N., long. 33° 55′ W., on 21 August 1956, appeared in the *Polar Record*, Vol. 8, No. 56, 1957.]

The glaciological and meteorological programme of the expedition was continued during the winter season.

In May 1957 a party of two laid a depot about 100 km. east of the station in preparation for the journey to the coast.

The whole party left the station on 24 June, each man hauling a sledge weighing about 125 kg. A region of deep crevasses was met with about 80 km. inside Charcots Land; the resulting deviations necessary lengthened the journey by about 600 km.

Cecilia Nunatak, in lat. 70° 36′ N., long. 28° 10′ W., was reached on 8 July. The most difficult part of the journey then began in the descent from the ice sheet; the terrain was too rough for sledges and four journeys had to be made to back-pack equipment down to sea level. Röhss Fjord was reached on 20 July, and the party was picked up by an aircraft belonging to Dr Lauge Koch's expedition and flown to Ella Ø. They returned to France in the *Rutha Dan*.

BRITISH EXPEDITION TO NORTH-WEST GREENLAND, 1957

[Summarized from information provided by J. W. Cowie.]

J. W. Cowie and F. R. Farley of the University of Bristol spent five weeks of the summer of 1957 making geological investigations in west Inglefield Land.

They reached Thule from København on 29 June and chartered an Eskimo-owned motor boat with a crew of three. They also engaged a local hunter. After journeying up the coast the main camp and depot was set up near Etah, and another camp at Kap Ingersoll in lat. 71° 45′ W., long. 78° 38′ N.

Rock exposures in the northern area visited were almost entirely confined to the cliffs of the north coast and the sides of major valleys, but were more extensive in the western coastal area and around Etah.

The party left from near Etah by motor-boat on 6 September and reached København on 6 October.

SOVIET ARCTIC EXPEDITIONS, 1957

[Chiefly from *Problemy Arktiki* [*Problems of the Arctic*], No. 4, 1958, p. 103–09.]

The Arctic Research Institute [Arkticheskiy Nauchno-Issledovatel'skiy Institut] had twenty-two expeditions in the field. The principal of these are summarized below.

The most important was the high latitude air expedition, led by M. M. Nikitin and employing 270 men and 17 aircraft.[1] Its tasks were to close down drifting station SP-4, relieve SP-6, establish SP-7, and set up on the drifting ice fourteen automatic weather stations and eleven radio beacons (for tracking ice movement). One weather station was placed at the North Pole on 16 May. Oceanographical observations were made at many points. The expedition was in the field from 28 March to 10 June, and again in the autumn for resupply of the drifting stations.

An expedition in the *Lena*, led by L. L. Balakshin, was the third in a series which has worked in the northern part of the Greenland Sea. It was at sea from September to December. The water exchange between the North Atlantic and the Arctic Ocean was the main subject of investigation.

G. A. Baskakov led a second expedition to study currents in the Kara Sea. This party, which had the use of the icebreaker *Fedor Litke* and two motor schooners, made extensive use of self-recording instruments which were left for the whole season.

There were also smaller oceanographical expeditions: the *Lomonosov* carried a party to the East Siberian and Chukchi Seas, the *Toros* to the Barents and Kara Seas.

In August and September a large expedition of sixty-five scientists and technicians under K. K. Fedchenko established an I.G.Y. station at Ostrov Kheysa in Zemlya Frantsa-Iosifa. The station is called Druzhnyy. Work here is concentrated on the upper atmosphere, ionosphere, aurora, cosmic rays and terrestrial magnetism. This is the only arctic station from which the Soviet I.G.Y. rocket programme is carried out.

Other organizations besides the Arctic Research Institute had parties in the field. The Research Institute of the Geology of the Arctic [Nauchno-Issledovatel'skiy Institut Geologii Arktiki] had eleven survey parties in various regions, including some in the Olenek basin in search of diamonds. The Institute of Geography [Institut Geografii] sent glaciological expeditions to Russkaya Gavan' in Novaya Zemlya, Ostrov Gukera in Zemlya Frantsa-Iosifa, and the river Shchuch'ya in Polyarnyy Ural to carry out an I.G.Y. programme.

THE NORTHERN SEA ROUTE IN 1957

[From *Vodnyy Transport* [*Water Transport*], 29 October and 14 November 1957, 23 January and 22 February 1958.]

In general, ice conditions were not easy. The Taymyr ice cluster in particular (in the western part of the Laptev Sea) was a serious impediment for much of the season. Well over 100 ships were employed, of which 79 (31 Soviet and 48 non-Soviet) called at the Yenisey. Total freight turnover appears to have been about 1½ million tons. The biggest single item was probably the export of timber from Igarka; Soviet ships participated to an increasing extent, bringing in freight for Noril'sk, which was offloaded at Dudinka, and taking timber out to Soviet ports. Timber was also exported from Tiksi to ports further east.

Ship movements were frequently upset by the ice, and the Arctic Research Institute was blamed afterwards for its ice forecasts, a third of which proved incorrect.

[1] See *Polar Record*, Vol. 8, No. 57, 1957, p. 519–21.

SWEDISH–FINNISH–SWISS INTERNATIONAL GEOPHYSICAL YEAR EXPEDITION TO NORDAUSTLANDET, 1957–58, AND SWEDISH EXPEDITION TO NORDAUSTLANDET, 1958–59: SEASON 1957–58

[From Gösta H. Liljequist, *Ymer*, Årg. 77, Hft. 4, 1957, p. 260–79, and *Dagens Nyheter*, 22 October 1957, 6 April, 25 June, 7, 9, 14, 18, 22, 24, 25, 26, 28, 29, 30 August and 1 September, 1958. Previous reference was made to this expedition in the *Polar Record*, Vol. 8, No. 56, 1957, p. 446, and Vol. 9, No. 58, 1958, p. 24–25.]

Eleven buildings were erected at the Swedish–Finnish–Swiss I.G.Y. expedition's base at Kinnvika on Murchisonfjorden. These were the main building (living quarters, kitchen, laboratory), reserve building, power house, cosmic ray hut, balloon hut, chemistry hut, terrestrial magnetism hut, auroral camera hut and the terrestrial magnetic variation hut. A small hut was also built to house the Swiss section's rotating frame aerial. On 15 August 1957 the first weather observations were sent to Norway, at first via Isfjord radio and later via Hopen.

The last summer guests left on Norsk Polarinstitutt's *Minna* on 28 August. The well near the main building dried up and froze, so a hole was blasted out a few hundred metres from the base and sufficed for a time, but water had later to be fetched by tractor from a lake 2 km. north of the base until the snow came. During September two excursions were made to look for remains of Russian hunting stations in the fjord. The foundations of buildings on Nordre Russøya were rediscovered, but not the base supposed to have been situated on Søre Russøya. At the beginning of October the Svalbard sysselman's vessel *Nordsyssel* visited Kinnvika, and fetched the Swiss physicist Brunner, who had been advised to return home for reasons of health. He was replaced by his countryman Pierre Wasserfallen.

The winter passed uneventfully and with all equipment functioning satisfactorily. On 13 December a telegram was received announcing the appointment of the leader of the expedition, Gösta Liljequist, to a professorship at Uppsala.

On 28–30 March 1958 a station consisting of a three-room snow cave was set up by weasel at lat. 79° 54′ N., long. 20° E. on Vestfonna, and occupied for fourteen days from 9 April. Investigations in meteorology, radiation and atmospheric electricity were made. On 8 May five members of the Swedish Glaciological Expedition arrived with a Norwegian airforce "Catalina". The machine landed on a snow runway measuring 1200 by 30 m. prepared by the expedition. On 29 June the remainder of the glaciological expedition arrived with the *Minna*.

Professor Liljequist left Nordaustlandet on 5 August when Norsk Polarinstitutt's *Sjøvern* called at Kinnvika. On board were Professor Siedlecki, leader of the Polish I.G.Y. expedition at Hornsund, and two of his assistants, who had come to visit the Swedish–Finnish–Swiss expedition. After calling at the Polish base on the way, *Sjøvern* reached Narvik on 18 August.

A smaller Swedish expedition had been formed to relieve the wintering party at Murchisonfjorden and to continue its work. The members are as follows:

W. Bischof, Leader and meteorologist
L. Andersson, Physicist (aurora and cosmic rays)
S. Hagberg, Mechanic
I. Klang, Radio operator and physicist (terrestrial magnetism)
P. Wasserfallen, Physicist (atmospheric electricity), who had gone home earlier in the year for a holiday.

The expedition left Gothenburg on 17 August on board the Swedish minelayer *Älvsnabben*. In Hinlopenstretet, however, *Älvsnabben* encountered heavy ice, reported by the Swedish naval staff to be the worst summer ice for 13 years, and had

to retire to Ny Ålesund on 23 August. A further attempt to get into Murchisonfjorden on 26 and 27 August was again prevented by ice north of Vestspitsbergen and *Älvsnabben* put into Virgohamna. Here *Sjøvern* was waiting and immediately began to take on board equipment and provisions from *Älvsnabben*. On 28 August *Sjøvern*, with the relief expedition, followed by *Nordsyssel*, which had also arrived in the area, started towards Kinnvika. After considerable difficulty and delay caused by fog, pack ice, and a change in wind which cleared Murchisonfjorden of ice but blocked Kinnvika itself, the two vessels managed to reach the expedition's base on 30 August. *Nordsyssel* took on board the glaciological group and Tollén, Gröndahl and Helimäki, and sailed from Kinnvika on the morning of the 31st. She went aground soon after, however, and had to be helped to get free by *Sjøvern*, whose own departure with the rest of the expedition and the equipment was thus delayed. The expedition finally transferred to *Älvsnabben* near Amsterdamøya and reached Tromsø on 3 September. While waiting at Virgohamna the men of *Älvsnabben* erected a memorial to Andrée and his companions at *Örnen*'s take-off point.

SWEDISH GLACIOLOGICAL EXPEDITION TO NORDAUSTLANDET, 1958

[By Weston Blake, jr. An account of work done by the expedition in 1957 appeared in the *Polar Record*, Vol. 9, No. 59, 1958.]

This expedition continued the field work started in 1956 and 1957. Members of the expedition were:

V. Schytt, Leader and glaciologist
R. Bergström, Glacial geologist
W. Blake, Jr., Glacial geologist
S. R. Ekman, Seismic engineer
A. Häggblom, Geographer
B. Jonsson, Mechanic
E. Palosuo, Ice crystallographer
P. Seppänen, Limnologist
S. Tegnér, Chemist

On 8 May Schytt, Blake, Ekman, Jonsson and Palosuo flew from Bardufoss, Norway, to Nordaustlandet with a Norwegian Air Force "Catalina". A successful landing was made on the ice in Murchisonfjorden at the base of the Swedish–Finnish–Swiss I.G.Y. Expedition. On 14 May the group arrived at the top of Vestfonna and Ahlmann station (lat. 79° 58′ N., long. 20° 09′ E.) was established at the site which Schytt visited in 1956 from the Soviet icebreaker *Ob'*. The first two weeks were devoted to hauling supplies up to Ahlmann station, testing the seismic equipment, and making glaciological observations. Also a visit was made to Lady Franklinfjorden to measure glacier motion on Søre Franklinbreen.

Between 29 May and 25 June a 450 km. weasel traverse of Vestfonna, Austfonna and Sørfonna was carried out. Seismic and glaciological stations were occupied every 5 km. on this traverse which extended east from Ahlmann station across Vestfonna and Rijpdalen to the centre of Austfonna, thence N.E.–S.W. between the top of Sørfonna and Kapp Leigh Smith, and finally E.–W. again near the 80th parallel. The highest point reached on Austfonna was approximately 810 m. above sea level, and here an ice thickness of 570 m. was recorded. The group returned to Murchisonfjorden on 17 June, travelling by dog sledge over the bay ice.

On 29 June *Minna* brought in the other four members of the expedition, and during the remainder of the summer the work was carried out in four groups. Schytt, Palosuo and Jonsson made detailed stratigraphic, temperature, and crystallographic studies of the firn and ice on Vestfonna and carried out thermal drilling. Ekman and Tegnér made seismic traverses from Ahlmann station (approximate elevation, 640 m. above sea level; ice thickness, 385 m.) to Ismåsetoppen and along

one of the two ablation–accumulation stake profiles between Ahlmann station and the western margin of Vestfonna. At the same time Tegnér collected snow and ice samples for later chemical analysis.

Häggblom and Seppänen obtained cores of sediments in Nordvika and a number of lakes east of Murchisonfjorden, and also collected water and biological samples. Blake and Bergström studied the raised beaches, glacial deposits and striae in Lady Franklinfjorden, Murchisonfjorden and on Lågøya.

The expedition reassembled in Murchisonfjorden on 20 August prior to departure with *Älvsnabben*. However, severe ice conditions prevented *Älvsnabben* from rounding Verlegenhuken, so the members of the expedition, as well as those of the Swedish–Finnish–Swiss I.G.Y. Expedition, were taken out through the ice by *Nordsyssel* and *Sjøvern*. A rendezvous was made with *Älvsnabben* near Amsterdamøya, and all personnel reached Tromsö on 3 September.

UNDER-ICE CROSSINGS OF THE ARCTIC BASIN: U.S.S. *NAUTILUS* AND U.S.S. *SKATE*, 1958

[Summarized from *The Times*, 9–14 and 16 August 1958, and *Engineering*, 22 August 1958.]

The nuclear powered submarine U.S.S. *Nautilus*, Commander W. R. Anderson, made the first successful under-ice crossing of the Arctic basin between 1 and 5 August 1958. The vessel, carrying a crew of 116 men, passed through Bering Strait on 19 July and submerged off Point Barrow, Alaska, at 12.37 hr. G.M.T. on 1 August. A valley in the ocean bed was followed which varied from 5 to 10 miles (8 to 16 km.) in width and 300 to 1200 ft. (90 to 360 m.) in depth, running parallel to the coast then leading into deeper water in the main polar basin. The submarine passed the North Pole at 03.15 hr. G.M.T. on 4 August and emerged in lat. 79° N. at 13.54 hr. G.M.T. on the 5th, after a voyage of 1830 miles under the ice. During most of the voyage the vessel cruised about 400 ft. (122 m.) under water and at a speed of about 20 knots. The depth of the water at the North Pole was 13,410 ft. (4090 m.). Waldo B. Lyon and a team of scientists from the United States Naval Electronics Laboratory were on board and carried out investigations during the voyage. Ice profiles were taken and the greatest depth of ice measured was 80 ft. (25 m.). Three separate systems of navigation were used during the voyage, each as a check to the others. The first was the North American Aviation SINS (ship's inertia navigation system), a three axis inertia navigation system. The other two systems, "estimated" and "dead-reckoning", were based on two types of naval gyro-compass and an aircraft type of directional gyro from the Sperry C11 Cyrosyn compass. The naval gyro-compasses worked normally up to lat. 89° N., about 100 miles from the North Pole, and were then replaced by the aircraft instrument until lat. 89° N. on the outward journey was reached. After surfacing, a solar fix was taken and the position of the vessel was found to be within 10 miles of that estimated by the three systems.

A slightly smaller nuclear-powered submarine, U.S.S. *Skate*, Commander J. Calvert, made a similar crossing, and surfaced in an opening in the ice about 40 miles from the North Pole at 01.47 hr. G.M.T. on 12 August. *Skate* also visited the two United States I.G.Y. drifting stations before leaving the Arctic.

These voyages, combined with the possibilities of atomic-powered submarines, obviously open up a field of great potential importance. An under-water route across the Arctic Ocean would shorten the distance between parts of Europe and North America by an appreciable amount, and also avoid seasonal weather hazards. It is likely that the effect on both strategic and trade routes in high northern latitudes will be very considerable.

ARCTIC INSTITUTE GREENLAND EXPEDITION, 1958

[By J. Tuck.]

An expedition sponsored by the Arctic Institute of North America visited a number of glaciers in west Greenland during July to September 1958. Members were: D. C. Nutt, Dartmouth College, and P. F. Scholander, physiologist, joint leaders; L. K. Coachman, oceanographer; W. Dansgaard, physicist (isotope); E. Hemmingsen, physiologist; O. Iversen, instrument mechanic; H. Jensen, carpenter; S. Skjelten, in charge of ship; H. Steen, physiologist; and J. Tuck, general assistant.

The object of the expedition was to continue investigations into a possible method of dating glacier ice by the composition of gas inclusions. The project had first been studied during the *Blue Dolphin* Labrador Expedition, 1954. Subsequent laboratory experiments were followed by a field examination of a Norwegian glacier, Storbreen in Jotunheimen, in 1957. An age dating for the terminal ice of this glacier of 700 years (± 120 years) had then been obtained, which agreed with glaciological estimates.

The party left Ålesund on 5 June in the Norwegian sealer *Rundøy* and reached Godthaab on the 17th. Samples of ice were obtained at the following places: Jakobshavns Isfjord, 20–26 June; Eqip sermia, 26–29 June; Kangilerngata sermia, 30 June–2 July; Qarajaqs Isfjord, 4–7 July; Kangerdlugssuaq, 7–11 July; Karrats Isfjord, 11–15 July; Ingnerit, 15–19 July; Upernaviks Isfjord, 22–26 July; south Melville Bugt, 20–27 July and Brede Fjord, 11–14 August. The party then left Prins Christians Sund on 16 August and reached Ålesund on the 24th. Eleven samples of ice for radio-carbon dating were obtained from glaciers and thirty hydrographic stations were kept during the cruise. The samples of ice are to be dated by Dr de Vries of Gröningen.

BRITISH NAVAL HYDROGRAPHIC SURVEYS IN THE FALKLAND ISLANDS DEPENDENCIES, 1956–57 AND 1957–58

[Summarized from an account by Lieut. C. J. C. Wynne-Edwards, R.N.]

1956–57

A Royal Naval Hydrographic Survey party was landed from H.M.S. *Protector* in November 1956 at Port Lockroy to chart the Bismarck Strait and surrounding areas.

Members of the party were: Lieut. C. J. C. Wynne-Edwards, R.N., hydrographic surveyor in charge; L/S A. R. Milnes and A/B J. Walsham, survey recorders; A/B D. Dickenson and A/B E. Savage, seaman assistants; and M. E. (1) O. Lynch, boat's engineer.

The party had with them a sectional prefabricated hut and a 29 ft. motor survey launch modified for use in ice and fitted with an echo sounder.

The survey was linked to the triangulation scheme of the F.I.D.S. station on Anvers Island (Base N), and was completed by mid-February 1957.[1]

1957–58

A survey party was landed at the Argentine Islands by R.R.S. *John Biscoe* on 1 January 1958. The naval party was increased by the addition of five F.I.D.S. personnel, two surveyors (from Base J, Prospect Point), a geologist, a medical officer and a radio operator. The work of the F.I.D.S. surveyors was later joined up with the hydrographic survey, and the medical officer carried out marine biology investi-

[1] This work has been published in a new Admiralty Chart No. 3572.

gations. Members of the complete party were: Lieut. C. J. C. Wynne-Edwards, R.N., hydrographic surveyor in charge; L/S A. R. Milnes and A/B V. T. Bloor, survey recorders; A/B K. Kenyon and A/B A. Lloyd, seamen assistants; M. E. (1) O. Nash, boat's engineer; B. Holmes and F. E. Wooden, surveyors (F.I.D.S.); R. Curtis, geologist (F.I.D.S.); Flt./Lieut. D. Jones, R.A.F., medical officer (F.I.D.S.); and P/O E. C. Clapp, R.N., wireless operator (F.I.D.S.).

A link was made with the previous year's triangulation at the northern end of Lemaire Channel, and the survey was then extended southwards to F.I.D.S. Base J, sixty miles distant, and westwards to include French Passage. The 29 ft. motor survey launch used the previous year was again employed, and, although the ice conditions were at times very bad, proved to be completely satisfactory.

The survey was completed early in April 1958 and the naval party re-embarked on R.R.S. *John Biscoe*.

THE AUSTRALIAN AUTOMATIC WEATHER STATION ON LEWIS ISLET, WILKES LAND

[By T. Burstall, Antarctic Division, Department of External Affairs, Australia.]

Early in 1955 the Australian National Antarctic Research Expeditions began investigating the possibility of setting up an automatic weather station in the Australian Antarctic Territory. In the following year an order was placed by the Commonwealth Meteorological Bureau with a French firm, Société Industrielle de Télécommande et de Télémecanique of Boulogne, which made a number of modifications to its product to suit the Australian requirements. Originally it had been intended to install it at the Windmill Islands during the southern summer of 1956–57, but owing to the shortage of cargo space on *Kista Dan* its installation was postponed until the following year. During 1957 it was erected at Point Nepean, Victoria, and underwent exhaustive tests by officers of the Commonwealth Meteorological Bureau.

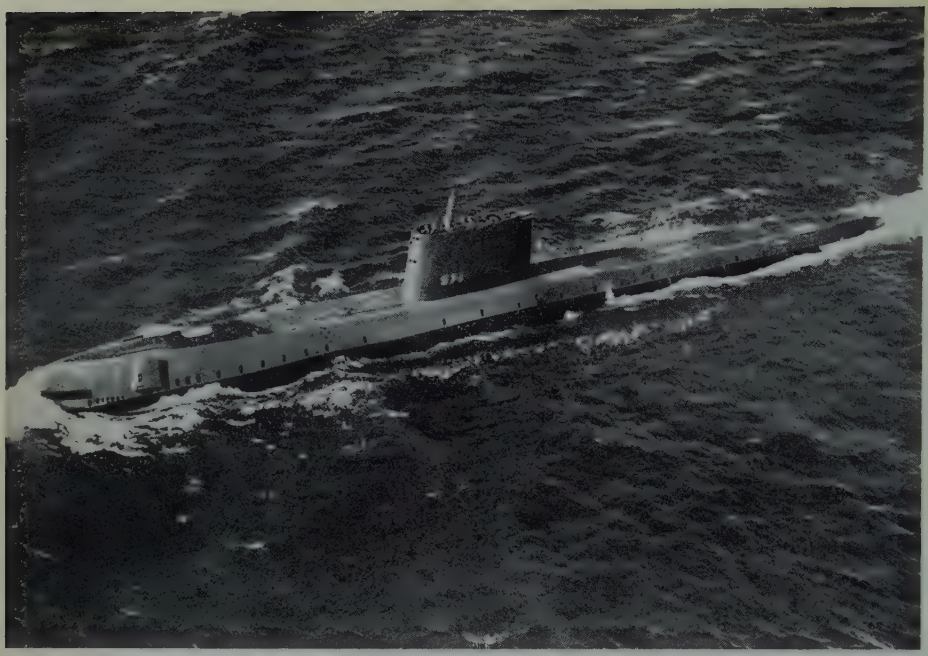
Establishment

In January 1958 the apparatus was transported from Melbourne to Lewis Islet, Antarctica, in *Thala Dan*. The expedition, led by Phillip Law, reached Lewis Islet, in lat. 66° 06′ S., long. 134° 22′ E., on 11 January, and unloading by pontoons began at 10.30 hr. on the northern side of the island. Teams of men carried stores, hut sections and the automatic weather station equipment up a 200-yard slope of snow which stretched almost to the summit of the island and then over rough rock to the high area which had been selected as the site for the station. By 8 p.m. the hut had been built and all the stores and equipment transferred to the site.

The aerial masts were erected and the hut fittings installed the following day and at 9.15 p.m. the *Thala Dan* left Lewis Islet for Oates Land, leaving D. Twigg (Mawson Radio Supervisor), E. Trigwell (Davis Radio Supervisor) and F. Elliott (Mawson Weather Observer) to set up the automatic equipment. During the following eleven days this was installed and tested, and the masts withstood gusts of wind which reached 80 m.p.h. without any indications of weakness. On 23 January the *Thala Dan* picked up the three men and, after setting the station's master clock to Greenwich Mean Time, set sail for Davis station.

Equipment. The automatic weather station was designed to operate unattended for twelve months in Antarctica. It measures temperature, pressure, wind speed and direction and transmits this information four times daily to the ANARE

Australian automatic weather station, Lewis Islet, Wilkes Land



U.S.S. *Nautilus.*

U.S.S. *Skate* moored to the pack ice at Drift Station Alpha after surfacing through one of the openings at that site. In the background are the quonset-type huts of the United States International Geophysical Year station.

Official U.S. Navy photographs

stations at Macquarie Island (lat. 64° 30′ S., long. 158° 57′ E.), Davis (lat. 68° 34′ S., long. 77° 58′ E.) and Mawson, (lat. 67° 36′ S., long. 62° 53′ E.).

The meteorological instruments consist of:

(1) An aneroid-type barometer.
(2) A resistance-type thermometer.
(3) A cup-type anemometer with a direction indicator.

These instruments are linked to elaborate electrical equipment which codes the information and transmits it by radio at set times determined by a pendulum clock. Transmissions are on frequencies of 7315 and 15,845 kc's at approximately 06.00, 12.00, 18.00 and 24.00 hr. G.M.T. daily.

The station sends out its call sign (VNX) fourteen times, then broadcasts its bulletin three times at dictation speed.

The bulletin gives:

(1) Atmospheric pressure to $\frac{1}{2}$ mb.
(2) Air temperature to $\frac{1}{2}$° C.
(3) Average wind-speed during the 5 min. preceding the broadcast to plus or minus 5 knots and the wind direction (16 points).

The duration of a complete broadcast is less than 2 min.

The station consists of three steel towers and a hut containing the broadcasting set, the batteries, the instruments and the coding apparatus. Two of the steel towers carry antenna and the third a wind-generator which recharges the batteries. These can function three months without recharging.

Results. Signals from the automatic weather station were heard from 24 January to 20 May 1958 at one or more of the receiving stations and relayed to Australia. Ninety observations were recorded at Macquarie Island, forty-four at Davis and three at Mawson, making a total of 137 successful transmissions. The observations were consistent with the weather situation and appear to be accurate within the specification of the instruments.

The weather station ceased transmitting on 20 May. This may have been due to a failure of the master clock, a break in the aerials or a breakdown in the transmitter.

The station will be completely overhauled early in 1959 when the ANARE relief vessel visits Lewis Islet.

ANGLO-AMERICAN PHYSIOLOGICAL TEAM IN ROSS DEPENDENCY, 1957–58

[By Dr G. Pugh.]

An Anglo-American physiological team visited the United States and New Zealand bases on Ross Island from December 1957 to March 1958.

The team was sponsored by the United States Office of Naval Research. The participation of the British members of the party, Dr G. Pugh, of the Division of Human Physiology, Medical Research Council, and Major J. Adam, of the Royal Army Medical Corps, was made possible by a generous grant from the Wellcome Trust. The American members were Dr N. Pace, Dr P. Hildebrand and W. Siri, of California University, Berkeley, California, and Captain C. Meyers, of the United States Navy Medical Service.

The party assembled in California in December 1957 and was transported by air to Antarctica under arrangements made by Task Force 43 with the United States Office of Naval Research.

The team studied energy expenditure, metabolism and responses to cold on members of the New Zealand party of the Trans-Antarctic Expedition, and I.G.Y. personnel at "Scott" base. A preliminary study was made of the effects of solar

radiation on the heat exchanges of the body. The problem of carbon monoxide poisoning was also investigated, since this was a real hazard on both the British and the New Zealand parties. The American members of the team studied the effects of exposure to extreme cold and physical stress on the activity of the adrenal cortex. A special study on the bacteriological aspects of life in Antarctica was carried out by Dr Myers.

With the help of air transport, it proved possible to visit United States field teams sometimes at great distances and to carry out studies at "Little America V" and the "Amundsen-Scott" station during the second half of February 1958. Major Adam spent some days with one of the New Zealand sledging teams and later joined Sir Vivian Fuchs' Trans-Antarctic Expedition party for the last three days of the journey to "Scott" base.

NOTES

EXTENSION OF I.G.Y. ACTIVITIES INTO 1959

At the Fifth General Assembly of the Special Committee for the I.G.Y. (C.S.A.G.I.) held in Moscow from 30 July to 9 August 1958, a proposal that the I.G.Y. be extended for an additional year was considered by the various working groups and by the Advisory Committee for the I.G.Y. (A.C.I.G.Y.). The final resolution, which represents a compromise between the views of the different delegations, was endorsed by the C.S.A.G.I. It reads as follows:

"The A.C.I.G.Y. recommends that observational and data-collecting activities in the geophysical and related sciences be conducted during 1959 on the same general plan as in 1957–58, under the direction of the C.S.A.G.I. or C.U.R.A.G.I., (Comité pour l'Utilisation des Resultats de l'Année Geophysique International) as far as practicable, and at such level, and in such fields as may be determined by each participating Committee. The name 'International Geophysical Co-operation 1959' is suggested for this period."

It is thus for the responsible scientific committees in each country, in co-operation with their governments, to decide on the extent to which I.G.Y. observations will be continued into 1959. In the Antarctic it is already clear that although changes in activity at individual stations will take place, the total level of activity during 1959 will be similar to that during the I.G.Y.

NORWEGIAN–SOVIET SEALING AGREEMENT, 1958

[Translated from Norwegian text in Storting proposisjon Nr. 75 (1958), Oslo.]

Agreement between the Government of Norway and the Government of the Union of Soviet Socialist Republics on measures for the regulation of the catching of seals and protection of the seal stocks in the north-eastern part of the Atlantic Ocean.

The Government of Norway and the Government of the Union of Soviet Socialist Republics

which desire to establish international co-operation with a view to achieving a maximum warrantable yield from the seal stocks in the waters of the north-eastern part of the Atlantic Ocean such that the size of these stocks can be increased and maintained at a level which will ensure a maximum continuing return, and

which desire to extend and co-ordinate the scientific investigations conducted concerning the condition of the seal stocks in this area, and

which desire to adopt effective measures in order to achieve these aims,

have decided to enter into the present Agreement and have nominated as their plenipotentiaries:

the Government of Norway: Minister Nils Lysø, and

the Government of the Soviet Union: Minister Aleksandr Akimovish Ishkov

who, having exchanged their credentials, which have been found to be in good and proper form, have agreed on the following:

Article I

1. The area to which this Agreement applies shall include the waters in the north-eastern part of the Atlantic Ocean east of Kap Farvel where the subjects of both countries engage in the catching of seals, that is, the Greenland Sea and the Norwegian Sea, together with Denmark Strait and the Jan Mayen grounds, and also the Barents Sea.

2. This Agreement shall cover the Harp Seal (*Phoca groenlandica*), the Hooded Seal (*Cystophora cristata*) and the Walrus (*Odobenus rosmarus*).

3. On the recommendation of the Commission mentioned in Article III this Agreement may be extended to cover in addition the Bearded Seal (*Erignathus barbatus*), the Ringed Seal (*Phoca hispida*) and the Polar Bear (*Ursus arctos*) in accordance with the provisions of Article VII.

4. None of the provisions of this Agreement may in any way whatsoever be considered as a limitation of the parties' sovereign rights within their territorial and inner waters.

Article II

1. In order to accomplish the purposes of this Agreement the parties have agreed to adopt the measures described in the Annex to the Agreement and the purpose of which is to regulate the catching of the Harp Seal, the Hooded Seal and the Walrus.

2. The Annex is an integral and inseparable part of the Agreement. All references to the Agreement shall be understood to include this Annex in the form it now has and with the changes it may undergo in accordance with Articles IV and VII.

Article III

1. The parties shall establish a commission consisting of up to three representatives from each country. Furthermore, the delegations from the two countries shall be free to take with them to the meetings of the Commission such advisers and observers as they may desire.

2. Unless the Commission shall decide otherwise, it shall hold one ordinary meeting annually, alternately in each of the two countries.

3. The meetings shall be presided over by a representative of the country in which the Commission is meeting.

4. Each country shall have one vote in the Commission. A valid resolution shall require unanimity.

Article IV

The Commission shall have the following functions:

(*a*) on the basis of scientific and practical investigations to make proposals to the two governments on the regulation of the catching operations and on changes or additions to the Annex mentioned in Article II.

(*b*) to make proposals to the two governments on scientific investigations to be undertaken by each of the parties separately or in collaboration, and on the co-ordination of such investigations.

(*c*) in the event of considering it necessary, to make proposals to the two governments for the supervision of the observance of the provisions concerning the regulation of catching operations which are contained in the Annex to this Agreement.

Article V

The parties undertake as far as it is practically possible to give the Commission such information of a statistical, practical and scientific character as it finds desirable for its work.

Article VI

1. Each of the parties shall bear the costs of its own scientific investigations and of its participation in the Commission.

2. The costs of any common investigations or other costs incurred in common shall be divided between the parties in accordance with the proposal of the Commission.

Article VII

1. The Commission's proposals on scientific investigations, on provisions for the regulation of the catching operations and for the supervision of their observance, on the covering of the costs of any common investigation, on other costs incurred in common, and on the extension of the agreement to other species of animal under the terms of Article I.3, shall be submitted to the two governments for approval and shall become binding when such approval has been given.

2. The proposed and approved provisions for the regulation of catching operations and the measures for the supervision of their observance shall be put into effect within two months of their becoming binding, unless the parties shall have agreed otherwise.

Article VIII

Each of the parties undertakes to put into effect such measures as are considered necessary to ensure the carrying out of this Agreement.

Article IX

1. Each of the parties has the right, irrespective of this Agreement, to give its subjects permission to catch sea mammals covered by this Agreement for the following purposes:

(*a*) for scientific investigations

(*b*) for the local population and for expeditions, on the condition that the raw material be used for food, fodder and other requirements of nutriment on the spot.

2. The parties shall inform the Commission of all such grants of permission.

Article X

1. States which are interested in co-operating in the regulation of the catching, and protection of the stocks, of the species of animal which this Agreement covers, may, with the consent of the parties, accede to the Agreement.

2. Application for such accession shall be made by diplomatic channels to the Government of Norway and the Government of the Soviet Union.

Article XI

Each of the parties may inform the other party in writing that it no longer wishes to be bound by one or more of the provisions in the Annex to this Agreement. Unless the parties shall have agreed on another time limit, the provision or provisions concerned shall cease to be binding twelve months after the other party has received the declaration.

Article XII

1. This Agreement shall be ratified and shall come into force on the day that the ratification documents are exchanged, which shall take place in Moscow as soon as possible.

2. Three years after this Agreement has come into force each of the parties may by written declaration to the other party give notice of termination of it, with effect eighteen months after such declaration has been received by the other party.

Drawn up in Oslo on 22 November 1957 in two copies with Norwegian and Russian text, both of which have the same validity.

Annex

Under the terms of Article II in the Agreement the following provisions for the regulation of catching operations are laid down and shall be made effective in respect of the subjects of the two countries from the day on which the Agreement comes into force:

1. The catching grounds to which reference is made in this Annex cover the following areas:

The Jan Mayen grounds ("West Ice"): The area along the ice edge off the east coast of Greenland between lat. 77° N. and a line drawn from Horn in Iceland westwards to lat. 66° 28′ N. and long. 30° W. and thereafter in a straight line to the middle of Kangerdlugssuak in Greenland.

The northern catching grounds ("North Ice"): The area along the ice edge in the northern part of the Greenland Sea north of lat. 77° N., limited on the east by a line running along long. 20° E.

The eastern catching grounds ("East Ice"): The area along the ice edge in the Barents Sea east of long. 20° E.

The catching grounds in Denmark Strait: The polar ice east of Greenland south of the above mentioned line between Horn in Iceland and Kangerdlugssuak in Greenland.

2. In respect of the catching grounds named under 1, the catching of Harp Seal and Hooded Seal is forbidden at any time of year whatsoever with the exception of the following periods:

The Jan Mayen grounds: ("West Ice"), 20 March, 07·00 hr. to 5 May 24.00 hr.

The northern catching grounds: ("North Ice"), 20 March, 07.00 hr. to 5 May, 24.00 hr.

The eastern catching grounds: ("East Ice"), 1 March, 07.00 hr. to 10 May, 24.00 hr.

The times mentioned above shall be determined according to Greenwich time.

3. In Denmark Strait Norwegian vessels which have in one or more of the years 1952 to 1956 engaged in catching operations in this area are provisionally permitted to engage in catching operations during the period 15 June, 07.00 hr. to 15 July, 24.00 hr. (Greenwich time).

4. The catching of Walrus is forbidden everywhere throughout the year. The parties' respective authorities may grant special permission for a limited catch or adult Walrus males for the needs of the local population and of expeditions alone, under the express condition that the raw material obtained from this catch be used for food, fodder or other local supply requirements.

5. It is forbidden to engage in the catching of marine animals by the use of poisons. No ways or methods of catching or attempting to catch marine mammals which lead to considerable loss of injured animals is permitted.

6. In the course of catching from ships animals which are in pools in the ice or in open water it is only permitted to use harpoon rifles with a line.

7. It is forbidden when catching marine mammals in shore colonies to litter the colonies with carcases and offal from the slaughtered animals, and likewise to make bonfires in the colonies.

8. Each of the parties shall itself lay down the detailed regulations for shore catching by local populations.

Ratification documents (Article XII) were exchanged in Moscow on 27 June 1958.

TENTH MEETING OF THE INTERNATIONAL WHALING COMMISSION, 1958

[Summarized from *Norsk Hvalfangst-Tidende*, Årg 47, No. 8, 1958, p. 387–416.]

The tenth meeting of the International Whaling Commission was held at The Hague from 23 to 27 June, 1958. Dr G. J. Lienesch (Netherlands), chairman of the Commission, presided and representatives of all seventeen contracting governments except Brazil, Mexico and Panama, were present. Italy and Portugal were represented by observers as were also the Food and Agriculture Organization of the United Nations, the International Council for the Exploration of the Sea and the International Association of Whaling Companies.

A review of the 1957–58 Antarctic season was given by the Bureau of International Whaling Statistics. Twenty factory ships with 237 catchers took part (12 catchers more than in 1956–57). Operations for baleen whales began on 7 January and ended on 16 March, as in the previous season. The total pelagic catch was 29,687 baleen whales and 6296 Sperm Whales from which were produced 1,843,188 barrels of whale oil and 300,343 barrels of sperm oil (at six barrels to the ton). By-products totalled 153,414 tons. The largest catch was taken in area III, 0° to 70° E. (35·7 per cent of the total pelagic baleen whale catch). The former sanctuary in the Pacific sector (70° W. to 160° W.) contributed 25 per cent of the pelagic baleen whale catch. The catch in area V (130° E. to 170° W.) was again small.

Each year one of the most important questions to be considered by the Commission is that of the Antarctic pelagic quota for the next season. The catch limit for 1955–56 was 15,000 Blue Whale units and it was reduced to 14,500 in 1956–57 and 1957–58. The Scientific Committee again expressed its concern about the state of the stocks of whales, but the Commission decided by a majority that the pelagic quota should again be fixed at 14,500 Blue Whale units for the 1958–59 season. (Within 90 days contracting governments are, however, entitled to lodge an objection to such decisions of the Commission if they do not wish to be bound by them.)

It was decided that there should be no change in the opening dates of the season for different species, nor in the period during which Humpback Whales may be taken in the Antarctic. The Commission recommended that the prohibition on the killing of Humpback Whales in the North Atlantic and in Antarctic area II (0° to 60° W.) should be continued until 1964. At the ninth meeting it was decided that the former sanctuary in the Pacific sector should remain open to whaling in 1958–59, but a decision on the question of opening the sanctuary in 1959–60 was postponed until next year's meeting.

At the time of the meeting the Protocol amending the Convention so as to permit the appointment of independent observers, in addition to national inspectors, had still not been ratified by three governments (Brazil, Mexico and Panama) so no action could be taken about this proposal.

The expenditure of the Commission for the budget year 1957–58 amounted

to just under £3000, slightly less than for the previous year. The Commission discussed whale marking as an aid to research on whale populations. They were informed that seventy-two marks had been recovered in the Southern Hemisphere since 1957, two of which were from whales marked 23 years ago. Some 850 more whales had been marked.

Mr R. G. R. Wall (United Kingdom) was appointed chairman and Mr G. Clark (Canada) vice-chairman for the usual period of three years, the period of office of the existing chairman and vice-chairman having expired. The Commission were notified of the resignation of their secretary Mr A. T. A. Dobson (United Kingdom) who has held that position since the Commission were first constituted in 1949.

The next meeting of the Commission will open in London on 22 June 1959, and the Scientific Sub-Committee will meet in March 1959.

NEW SOVIET ICE-STRENGTHENED SHIPS

[From *Pravda*, 26 April 1957, and *Morskoy Flot*, 1958, No. 5, p. 32.]

The U.S.S.R. took delivery of three more ice-strengthened ships of the *Lena*-class in 1957. The three ships she already has in this class[1]—*Lena*, *Ob'* and *Yenisey*—have proved a success in both Arctic and Antarctic. Like them, the new ones were built in Holland, with a displacement of 12,600 tons and Diesel-electric propulsion developing 8200 h.p. They are called *Angara*, *Indigirka* and *Baykal*.

NEW GEOGRAPHICAL INSTITUTE IN SIBERIA

[From *Izvestiya Akademii Nauk SSSR. Seriya Geograficheskaya* 1958, No. 1, p. 3.]

The Academy of Sciences of the U.S.S.R. decided in 1957 to create a Siberian branch. This is to have two large research centres, one near Novosibirsk and one near Irkutsk, each comprising a number of scientific institutes. The Irkutsk centre is to include an Institute of Geography [Institut Geografii], which will have the basic task of studying and evaluating the natural resources of Siberia and of the Soviet Far East. A notable feature of the new institute is to be its obligation to work not only in Soviet territory, but in China and Mongolia.

The Director and organizer is Academician I. P. Gerasimov (who is also Director of the Institute of Geography in Moscow), and his deputy is V. A. Krotov.

SOVIET ORGANIZATIONS CONCERNED WITH THE ANTARCTIC

The present Soviet expedition to the Antarctic is under the scientific direction of the Academy of Sciences of the U.S.S.R. [Akademiya Nauk SSSR], while executive responsibility and logistics are the concern of the Chief Administra-

[1] See *Polar Record*, Vol. 7, No. 50, 1955, p. 428.

tion of the Northern Sea Route [Glavsevmorput']. The chief scientific organ of Glavsevmorput' is the Arctic Research Institute, and the central role it has played is reflected in its change of name, in the summer of 1958, to the Arctic and Antarctic Research Institute [Arkticheskiy Antarkticheskiy Nauchno-Issledovatel'skiy Institut].

The co-ordinating body was at first the Academy of Sciences Council for Antarctic Investigations [Soviet po Antarkticheskim Issledovaniyam], set up in 1955 under the chairmanship of Academician D. I. Shcherbakov. The Academy replaced this Council in September 1958 by the Inter-Departmental Antarctic Commission [Mezhduvedomstvennaya Antarkticheskaya Komissiya], with Academician Shcherbakov still chairman. Its main functions are the co-ordination of research and publication of results. It will also act in a representative role at international meetings.

ÉCOLE DES HAUTES ÉTUDES: CENTRE FRANÇAIS D'ÉTUDES ARCTIQUES

[Summarized from information provided by Professor J. N. Malaurie.]

The Centre Français d'Études Arctiques was opened on 1 November 1957 as a part of the École des Hautes Études, VIème section, 54 rue de Varenne, Paris. It is under the direction of Professor J. N. Malaurie and has a permanent staff of five. The object of the centre is the social and economic study of Arctic races and regions. It is financed partly by the Ministère de l'Education Nationale and partly by l'Association privée Marc Bloch.

Admission to the Centre is by selection only, with no qualifications of age or particular standard of education, and is subject to confirmation after a period of three months or more. The course of study lasts for three years, each academic year beginning in the first week of November and ending in the last week in June.

In addition to providing lectures on social and economic aspects of the Arctic, the Centre offers assistance in research projects, bibliographic aids and publications. The publications section will publish original articles, students' theses, reports of national commissions, and works of importance in less common languages, also maps and a classified critical bibliography. There is also a photographic section.

An annual report on the activities of the Centre will be published.

ALASKA BECOMES 49TH STATE OF UNITED STATES

On 3 June 1958 a statehood Bill was passed through the Senate of the United States by which Alaska became a state of the Union. The Bill called for acceptance by means of a referendum in Alaska before final presidential signature.

The referendum was held at the end of August and returns were overwhelmingly in favour of the Bill, which had received presidential signature on 7 July 1958.

THE NORTH AMERICAN "DISTANT EARLY WARNING LINE"

[Security regulations have hitherto prevented the publication of any details of this major activity. The following is a summary of the information so far released.]

The "Distant Early Warning (DEW) Line" is the most northerly of the three lines of a radar network stretching across north America and designed to give warning of air attack from across the Arctic Ocean. The first of these, the "Pine Tree Line", was completed in 1954 and runs roughly along the Canadian–United States boundary. It was built, and is manned, jointly by the two countries and was expected to give major towns up to an hour's warning of an air attack. The increasing speed of modern aircraft, however, made it advisable to extend the system northwards and two more lines were built. The "Mid-Canada Line", or "McGill Fence", following the 55th parallel, was opened in June 1957; it was built and is manned by Canada. The third line, the "DEW Line" follows the 70th parallel for 2500 miles (4000 km.) across the Arctic coast of North America, stretching from the east coast of Baffin Island to Point Barrow. The construction of this line was the responsibility of the United States and was carried out by the Western Electric Company, a subsidiary of the Bell Telephone System, who in turn subcontracted the work to an American and two Canadian firms.

During the winter of 1953–54 experimental work was carried out at a number of prototype stations in the Barter Island, Alaska, area. These proved that the radar system would work satisfactorily in Arctic conditions and, at the end of 1954, it was decided to extend the line of stations across the continent. The project was divided into three sections, one covering Alaska and two northern Canada. Each of these was divided into two sectors of about 500 miles each. Preliminary work on the siting of stations and the establishment of construction camps was carried out by air during the spring of 1955, when over 50,000 tons of material were delivered by the United States Air Force and commercial firms. The precise siting of stations depended on electronic requirements and a number had to be built in places inaccessable by sea and far from possible natural air-strips. In such cases tractors were dropped by parachute to level the air-strips and construct roads to enable aircraft to bring in supplies and materials. As soon as ice conditions permitted, convoys from Seattle and Halifax, led by United States and Canadian icebreakers, brought over 120,000 tons of material and over 7000 workmen to distributing centres. Fifty-seven ships and 15,000 men were engaged in the convoys during the summer of 1955.

There are three types of station; "main", "auxiliary" and "intermediate". "Main" stations are administrative and supply centres and are each manned by about forty men. They are equipped with scanning radar designed to search out and track aircraft. "Auxiliary" stations, about 100 miles apart and manned by about twenty men, have the same equipment. "Intermediate", three-men, stations only transmit a static signal that reports contact with aircraft to the nearest larger station. The project was completed at the end of July 1957 and stations are manned and operated by the Federal Electric

Corporation on behalf of the United States Air Force, whose responsibility is limited to supervision and control.

The agreement between the two countries to establish the system came into force on 5 May 1955. In addition to clauses concerning Canada's sovereign rights over the stations built and manned by the United States and her right to take over these installations, provision is made for the welfare of the Canadian Eskimo and for the protection of wildlife. Nevertheless, there is no doubt that the building of the DEW Line has fundamentally altered living and working conditions in the north American Arctic; new transport facilities, new fields of employment and economic developments are introducing a new pattern of life and irrevocably replacing the old.

PROPOSED INTERNATIONAL ANTARCTIC CONFERENCE

The following is the text of a statement made by the President of the United States on 3 May 1958.

The United States is dedicated to the principle that the vast uninhabited wastes of Antarctica shall be used only for peaceful purposes. We do not want Antarctica to become an object of political conflict. Accordingly, the United States has invited eleven other countries, including the Soviet Union, to confer with us to seek an effective joint means of achieving this objective.

We propose that Antarctica shall be open to all nations to conduct scientific or other peaceful activities there. We also propose that joint administrative arrangements be worked out to ensure the successful accomplishment of these and other peaceful purposes.

The countries which have been invited to confer are those which have engaged in scientific activities in Antarctica over the past nine months in connection with the International Geophysical Year. I know of no instance in which international co-operation has been more successfully demonstrated. However, the International Geophysical Year terminates on December 31, 1958. Our proposal is directed at insuring that this same kind of co-operation for the benefit of all mankind shall be perpetuated after that date.

I am confident that our proposal will win the wholehearted support of the peoples of all the nations directly concerned, and indeed of all other peoples of the world.

The text of the Note which was sent by the Government of the United States to the Governments of the eleven other countries[1] participating in the International Geophysical Year activities in Antarctica was as follows:

I have the honour to refer to the splendid example of international co-operation which can now be observed in many parts of the world because of the co-ordinated efforts of scientists of many countries in seeking a better understanding of geophysical phenomena during the current International Geophysical Year. These co-ordinated efforts of the scientists of many lands have as their objective a greatly increased knowledge of the planet on which we live and will no doubt contribute directly and indirectly to the welfare of the human race for many generations to come.

Among the various portions of the globe where these co-operative scientific endeavours are being carried on with singular success and with a sincere consciousness of the high ideals of mankind to which they are dedicated is the vast and

[1] Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, Union of South Africa, U.S.S.R. and the United Kingdom.

relatively remote continent of Antarctica. The scientific research being conducted in that continent by the co-operative efforts of distinguished scientists from many countries is producing information of practical as well as theoretical value for all mankind.

The International Geophysical Year comes to a close at the end of 1958. The need for co-ordinated scientific research in Antarctica, however, will continue for many more years into the future. Accordingly, it would appear desirable for those countries participating in the Antarctic programme of the International Geophysical Year to reach agreement among themselves on a programme to assure the continuation of the fruitful scientific co-operation referred to above. Such an arrangement could have the additional advantage of preventing unnecessary and undesirable political rivalries in that continent, the uneconomic expenditure of funds to defend individual national interests, and the recurrent possibility of international misunderstanding. It would appear that if harmonious agreement can be reached among the countries directly concerned in regard to friendly co-operation in Antarctica, there would be advantages not only to those countries but to all other countries as well.

The present situation in Antarctica is characterized by diverse legal, political, and administrative concepts which render friendly co-operation difficult in the absence of an understanding among the countries involved. Seven countries have asserted claims of sovereignty to portions of Antarctica, some of which overlap and give rise to occasional frictions. Other countries have a direct interest in that continent based on past discovery and exploration, geographic proximity, sea and air transportation routes, and other considerations.

The United States for many years has had, and at the present time continues to have, direct and substantial rights and interests in Antarctica. Throughout a period of many years, commencing in the early eighteen-hundreds, many areas of the Antarctic region have been discovered, sighted, explored and claimed on behalf of the United States by nationals of the United States and by expeditions carrying the flag of the United States. During this period, the Government of the United States and its nationals have engaged in well-known and extensive activities in Antarctica.

In view of the activities of the United States and its nationals referred to above, my Government reserves all of the rights of the United States with respect to the Antarctic region, including the right to assert a territorial claim or claims.

It is the opinion of my Government, however, that the interests of mankind would best be served, in consonance with the high ideals of the Charter of the United Nations, if the countries which have a direct interest in Antarctica were to join together in the conclusion of a treaty which would have the following peaceful purposes:

(*a*) Freedom of scientific investigation throughout Antarctica by citizens, organizations, and governments of all countries; and a continuation of the international scientific co-operation which is being carried out so successfully during the current International Geophysical Year.

(*b*) International agreement to ensure that Antarctica be used for peaceful purposes only.

(*c*) Any other peaceful purposes not inconsistent with the Charter of the United Nations.

The Government of the United States is prepared to discuss jointly with the Governments of the other countries having a direct interest in Antarctica the possibility of concluding an agreement, which would be in the form of a treaty, for the purpose of giving legal effect to these high principles. It is believed that such a treaty can be concluded without requiring any participating nation to renounce whatever basic historic rights it may have in Antarctica, or whatever claims of sovereignty it may have asserted. It could be specifically provided that such basic

rights and such claims would remain unaffected while the treaty is in force, and that no new rights would be acquired and no new claims made by any country during the duration of the treaty. In other words, the legal *status quo* in Antarctica would be frozen for the duration of the treaty, permitting co-operation in scientific and administrative matters to be carried out in a constructive manner without being hampered or affected in any way by political considerations. Provision could likewise be made for such joint administrative arrangements as might be necessary and desirable to ensure the successful accomplishment of the agreed objectives. The proposed treaty would be deposited with the United Nations, and the co-operation of the specialized technical agencies of the United Nations would be sought. Such an arrangement would provide a firm and favourable foundation for a continuation of the productive activities which have thus far distinguished the International Geophysical Year; would provide an agreed basis for the maintenance of peaceful and orderly conditions in Antarctica during years to come; and would avoid the possibility of that continent becoming the scene of international discord.

In the hope that the countries having a direct interest in Antarctica will agree on the desirability of the aforesaid high objectives, and will work together in an effort to convert them into practical realities, the Government of the United States has the honour to invite the Government of to participate in a Conference for this purpose to be convened at an early date at such place as may be mutually agreeable.

Accept, Excellency, the renewed assurances of my highest consideration.

I.G.Y. ANTARCTIC WEATHER CENTRAL AT "LITTLE AMERICA V"

[By W. B. Moreland, in charge Antarctic Weather Central 1957. MS. received 15 September 1958.]

Weather Central, at "Little America V" station, Ross Dependency, is part of the United States International Geophysical Year contribution in Antarctica. It began operations on 1 July 1957, and has two main objectives. The first is to collect weather reports from both land and ship stations in the Southern Hemisphere for the purpose of constructing current hemispheric upper air and surface weather charts. These analyses are broadcast so that they can be used by meteorologists at other Antarctic stations for making local weather forecasts. The second objective is to broadcast an Antarctic weather collective consisting of the raw weather data. This collective can be used by the Southern Hemisphere meteorological services in preparing weather analyses and forecasts.

In order to accomplish the above objectives a mother–daughter type of network was planned by the C.S.A.I. working Group on Antarctic Radio Transmission. The basic operation of such a network is simple. The mother station, at a prearranged time, contacts each daughter station and collects their weather reports. It then relays the reports to the Weather Central. The number and frequency of transmissions made by each station depends largely upon the size of the station. Generally, a station with one radio operator can maintain three daily schedules. Larger stations can handle as many as eight a day.

Since weather charts are usually based on the four synoptic hours of 00.00,

06.00, 12.00 and 18.00 G.M.T., the schedules are arranged to have each mother station transmit the reports as soon as possible after each of these hours. The co-operation received by the Weather Central from all the Antarctic stations has been excellent.

In the beginning the analyses, by the time they were completed and transmitted, were 24 to 30 hours old. However, by continually improving and increasing the frequency of schedules, it is now possible to cut this time down to twelve hours. Although a 12-hour time interval by middle latitude standards is large, in the Antarctic it is a major accomplishment.

The basic analysis programmes at Weather Central consists of four surface charts; two 700 mb., one 500 mb., and one 300 mb. charts daily. In addition pseudo-adiabatic charts are plotted for all the Antarctic stations taking upper air sounding. Time cross-sections of temperature, wind, etc., at various altitudes are prepared for nine Antarctic stations. In order to study the Antarctic stratospheric circulation 50 mb. charts are prepared once daily. In addition to the routine analysis programme special research studies are undertaken to study the Antarctic circulation. The results of one of these projects has already been published.[1] Weekly discussions are also held during the winter to review the significant weather conditions that have occurred during the previous week.

At first the circulation features over the Antarctic were based largely on interpretation of information obtained from stations located around the periphery of the continent. However, the establishment of interior stations in Marie Byrd Land, Eastern Antarctica[2] and at the South Pole have made possible a more accurate description of all the Antarctic circulation.

From analyses made at the Weather Central the existence of a major cyclone track from the Ross Sea area, through Marie Byrd Land, to the Weddell Sea has been clearly established. Cyclones were also found to move through the interior of Eastern Antarctica,[2] but there tracks were usually quite far south (near lat. 80° S.). This southerly track was due to the blocking action of a large anticyclone located over the central portion of the Eastern Antarctic[2] plateau. The presence of this large anticyclone also kept the Eastern Antarctic coastal cyclones from moving a great distance into the interior. Normally the cyclone tracks in this region were parallel to the coast. Since clear skies, light winds and strong outgoing radiation are associated with the centre of this anticyclone, it is quite likely that this region experiences winter temperatures which are the coldest found anywhere on the earth's surface.

Of the analysed charts, one surface, one 700 mb. and one 500 mb. chart are transmitted daily. In addition an Antarctic weather collective is transmitted four times a day.

The greatest single problem in operating Weather Central has been the occurrence of frequent radio fadeouts. During these fadeouts little data can be received or transmitted and the continuity of analysis is destroyed;

[1] V. I. Rastoguev *and* J. A. Alvarez. Descriptions of the Antarctic Circulation observed from April to November 1957 at the I.G.Y. Antarctic Weather Central, Little America Station, *I.G.Y. World Data Center A, General Report Series*, No. 1, 1958.

[2] For criticism of this nomenclature see p. 358.

when the data again are received, it takes a day or two to restore this continuity.

The staff of the Weather Central consists of wintering groups augmented by additional personnel during the Antarctic summer. It included representatives from Argentina, New Zealand and the U.S.S.R. during 1956–57, and from Argentina, Australia, France, South Africa and the U.S.S.R. during 1957–58. They were as follows:

1956–57	*1957–58*
W. B. Moreland, U.S.A., in charge	T. I. Gray, Jr., U.S.A., in charge
J. A. Alvarez, Argentina	J. Alt, France
T. Edie, New Zealand (summer)	A. J. Arruiz, Argentina
J. Krank, U.S.A.	P. D. Astapenko, U.S.S.R.
B. Lieske, U.S.A.	H. B. Cochrane, U.S.A.
V. I. Rastoguev, U.S.S.R.	C. F. Fopay, U.S.A.
M. Rubin, U.S.A. (summer)	K. Morley, Australia
R. C. Taylor, U.S.A.	N. J. Ropar, U.S.A.
	H. Van Loon, South Africa (summer)

The following is a list of mother and daughter stations reporting to Weather Central:

Mother stations	*Daughter stations*	*Grand-daughter stations*
"McMurdo" (U.S.A.)	1. "Amundsen–Scott" station (U.S.A.)	
	2. "Scott" station (N.Z.)	
	3. "Dumont d'Urville" (France)	Station "Charcot" (France)
	4. Port-aux-Français, Iles de Kerguelen (France)	
	5. "Wilkes" station (U.S.A.)	
	6. "Hallett" station (U.S.A.–N.Z.)	
"Little America V" (U.S.A.)	1. "Byrd" station (U.S.A.)	
Mawson (Australia)	1. Davis (Australia)	
	2. Kronprinsesse Märtha Kyst (Norway)	Shore Base (Norway)
	3. "Syowa" (Japan)	Advanced Base (Japan)
	4. Base "Roi Baudouin" (Belgium)	
"Mirnyy" (U.S.S.R.)	1. "Vostok" (U.S.S.R.)	
	2. "Sovetskaya" (U.S.S.R.)	
	3. "Pionerskaya" (U.S.S.R.)	
	4. "Komsomol'skaya" (U.S.S.R.)	
Stanley (U.K.)	1. Grytviken (U.K.)	
	2. Admiralty Bay (U.K.)	
	3. Port Lockroy (U.K.)	

Mother stations	*Daughter stations*	*Grand-daughter stations*
Stanley (U.K.) *cont.*	4. Argentine Islands (U.K.)	
	5. Hope Bay (U.K.)	
	6. Horseshoe Island (U.K.)	
	7. Halley Bay (U.K.)	
	8. View Point (U.K.)	
	9. Detaille Island (U.K.)	
	10. Deception Island (U.K.)	
	11. Signy Island (U.K.)	
	12. Shackleton (U.K.)	"South Ice" (U.K.)
	13. "Ellsworth Station" (U.S.A.)	
	14. Prospect Point (U.K.)	
Decepción (Argentine)	1. "General San Martin" (Argentine)	
	2. "Almirante Brown" (Argentine)	
	3. "Teniente Camara" (Argentine)	
	4. "Esperanza" (Argentine)	
	5. "Orcadas" (Argentine)	
	6. "Melchoir" (Argentine)	
	7. "General Belgrano" (Argentine)	
"General Bernardo O'Higgins" (Chile)	1. "Arturo Prat" (Chile)	
	2. "Pres. Gonzales Videla" (Chile)	
	3. "Pedro Aguirre Cerda" (Chile)	

THE NAMES "EAST ANTARCTICA" AND "WEST ANTARCTICA"

The Antarctic continent comprises two main regions of different geological character, separated by the relatively low-lying area between the Weddell Sea and Ross Sea. These two regions are sometimes referred to by the rather vague names "East Antarctica" and "West Antarctica", originally proposed by E. S. Balch in his work *Antarctica* (Philadelphia, 1902, p. 13). The same names have also been applied, perhaps more frequently, in relation to the Greenwich meridian. Apart from the existence of these two quite different definitions, it is confusing for those who live in Australia and New Zealand to have "East Antarctica" to the westward and "West Antarctica" to the eastward.

One is reminded of the similar confusion which has arisen from the division of the Arctic Ocean into "East" and "West", with Russians and North Americans each understanding the exact opposite by these names.[1] For the

[1] *Polar Record*, Vol. 7, No. 50, 1955, p. 417.

same reason "East Antarctica" and "West Antarctica" are unsuitable for international use, and it is to be hoped that they will not gain currency.

At this stage the writer hesitates to suggest alternative names. We do not yet know whether there is any clear morphological division of the continent into two parts, and until the nature and position of any supposed depression between the Weddell Sea and Ross Sea has been established, it seems wiser to use terms like Pacific sector, or the existing place-names which refer to smaller areas.

BRIAN ROBERTS

S.C.A.R. BULLETIN

No. 1, *January* 1959

Aims and establishment of S.C.A.R.

In December 1956 the United States National Committee for the International Geophysical Year submitted a proposal to C.S.A.G.I. that the I.G.Y. antarctic programme should be continued for an additional year in order to realize the full scientific benefit from the large investment in stations and equipment made by the twelve nations participating in the programme.

The proposal was approved at the Fourth C.S.A.G.I. Conference in June 1957, and a recommendation submitted to the I.C.S.U. Executive Board that a committee should be set up to examine the merits of further general scientific investigations in Antarctica. The I.C.S.U. Board approved the creation of the *ad hoc* committee which met in Stockholm in September 1957, under the convenorship of Dr N. Herlofson.

Members of the Committee were: Argentina, L. M. de la Canal; Chile, R. Canas-Montalva; France, A. Gougenheim; Norway, H. Solberg; U.K., Sir David Brunt; U.S.A., H. Wexler; U.S.S.R., M. M. Somov. Observers: Japan, S. Shima; I.C.S.U., B. Lindblad. Secretary: V. Schytt.

The Committee resolved that there was need for further international organization of scientific activity in Antarctica and recommended that I.C.S.U. should establish a committee to undertake this task. This Special Committee on Antarctic Research (S.C.A.R.) should consist of a delegate from each nation actively engaged in Antarctic research, and representatives of the International Unions of Geography (I.G.U.), Geodesy and Geophysics (I.U.G.G.), Biological Sciences (I.U.B.S.) and Scientific Radio (U.R.S.I.). Each delegate should be authorized to bring with him to meetings advisers in various scientific disciplines, logistics and communications.

It was also resolved that the continuation of scientific activity in antarctic research should be regarded as being inspired by the interest roused by the activities of the I.G.Y. but in no way as an extension of the I.G.Y.

Members of S.C.A.R.

The following are the permanent delegates to S.C.A.R., October 1958:

Argentina	R. N. Panzarini, through the Government of Argentina
Australia	K. E. Bullen, through Academy of Science, Canberra
Belgium	J. van Mieghem, through Académie Royale de Belgique and Koninklijke Vlaamse Academie voor Wetenshappen, Letteren en Shone Kunsten van Belgie
Chile	D. H. Fuenzalida
France	A. Gougenheim, through l'Académie des Sciences
Japan	T. Nagata, through Science Council of Japan
New Zealand	E. I. Robertson, through Royal Society of New Zealand
Norway	L. Harang, through Det Norske Videnskaps-Akademi

U.K.	G. de Q. Robin, through Royal Society
U.S.A.	L. M. Gould (alternative H. Wexler), through National Academy of Sciences
U.S.S.R.	M. M. Somov, through Academy of Sciences of U.S.S.R.
I.G.U.	V. Schytt
I.U.B.S.	A. F. Bruun
I.U.G.G.	G. R. Laclavère
U.R.S.I.	L. Harang

First meeting of S.C.A.R., held at The Hague, 3 to 5 February 1958

Present. Convenor: Dr N. Herlofson
Delegates: Argentina, L. de la Canal; Australia, K. E. Bullen; Belgium, J. van Mieghem; France, A. Gougenheim; Japan, T. Rikitake; Norway, L. Harang; United Kingdom, Sir James Wordie; U.S.A., L. M. Gould; U.S.S.R., M. M. Somov; I.G.U., V. Schytt; I.U.B.S., A. F. Brunn; I.U.G.G., G. R. Laclavère
Advisers: Belgium, F. Bastin; U.S.A., H. Wexler
Representatives of I.C.S.U.: R. Fraser and E. Herbays

The main objects of this meeting were:

(*a*) To recommend a constitution for the Committee. A proposed constitution was circulated before the meeting and later recommended by it to I.C.S.U. (see p. 366). It was ratified in October 1958 at the Eighth General Assembly of I.C.S.U.

(*b*) To make provisional appointments of officers for the Committee. The following were elected: President, G. R. Laclavère; Vice-President, K. E. Bullen; Secretary, V. Schytt (G. de Q. Robin subsequently became Acting Secretary during Schytt's absence in Spitsbergen during the summer of 1958). To ensure continuity the President was elected in the first instance for two years, the Vice-President for one year and the Secretary for three years.

(*c*) To frame a budget for the work of the Committee. Two members of a Finance Committee were elected: L. M. Gould and M. M. Somov, with H. Wexler acting as deputy to the former if necessary. The Treasurer of I.C.S.U. is an ex-officio member of this Committee.

It was decided that the basic contribution for 1958 should be $500 per nation which would cover the estimated cost of $6,000 for the expenses of S.C.A.R.

If the budget for future years requires more than this sum, the excess should be divided between the nations in proportion to their activity in the Antarctic, this activity to be defined by the following category numbers:

Category 1	1 to 10	
Category 2	11 to 20	
Category 3	21 to 50	wintering members.
Category 4	51 to 100	
Category 5	Over 100	

It was not expected that this formula would result in a total contribution of more than $2000 per year from any participating nation.

(*d*) To prepare a plan for the scientific exploration of Antarctica in the years following the I.G.Y. This plan (see p. 367) was formed and amended during

the first and second meetings of S.C.A.R. and circulated to members of S.C.A.R. and to the Special Committee on Oceanographical Research (S.C.O.R.). It was decided to circulate this, and other S.C.A.R. papers, to outside countries and institutions to encourage their participation.

Other items of important business included:

(*a*) Area of interest of S.C.A.R. See p. 364.

(*b*) National reports on projected activities in Antarctica. These were understood to be tentative and not binding on the nations concerned.

(*c*) Formation of Working Groups. Three Working Groups were set up: Group I. Meterology, cosmic physics, biology, physiology and oceanography; Group II. Geology, glaciology, morphology and cartography; Group III. Seismology, gravity and vulcanology.

Reports from these groups were later read by J. van Meighem (Group I), L. M. Gould (Group II) and K. E. Bullen (Group III).

(*d*) I.C.S.U. was requested to inform the United Nations, through proper channels, of the existence and purpose of S.C.A.R.

(*e*) It was decided that suitable relations with S.C.O.R. and other international scientific bodies interested in Antarctic research should be established for the interchange of information and co-ordination of programmes. Also that co-operative programmes by several nations should be encouraged to enable maintenance of the present Antarctic station network, and possible extensions.

(*f*) The Committee expressed its gratitude to the Administrative Secretary of I.C.S.U. and his staff for help given during the meeting and acknowledged the financial assistance offered by I.C.S.U. to initiate the work of S.C.A.R.

Second meeting of S.C.A.R., held in Moscow 4 *to* 11 *August* 1958

Present.	Delegates:	Argentina, R. N. Panzarini; Australia, K. E. Bullen; Belgium, J. van Meighem; France, B. Imbert; Japan, M. Miyadi; New Zealand, E. Robertson; Norway, L. Harang (also representing U.R.S.I.); South Africa, M. P. van Rooy; United Kingdom, G. de Q. Robin; United States, H. Wexler; U.S.S.R., M. M. Somov; I.G.U., B. Bolin; I.U.B.S., L. Zentevitch; I.U.G.G., G. R. Laclavère
	Observers:	S.C.O.R., G. Böhnecke; W.M.O., O. Ashford
	Advisers:	Argentina, O. Schneider; Australia, W. J. Gibbs, F. Jacka; France, S. Emery, R. Pone, P.-E. Victor; Norway, A. Eliassen; United States, M. D. Cartwright; U.S.S.R., V. F. Burkhanov, K. Krichak, D. I. Shcherbakov

The representatives from W.M.O. and S.C.O.R. attended the meeting by invitation.

(*a*) National Antarctic Committees. It was reported that the following countries had formed these committees: Australia, Belgium, France, Japan, New Zealand, South Africa. The United States had already formed a Polar Committee which would act as the National Antarctic Committee for the purposes of S.C.A.R. The U.S.S.R. was in the process of forming a new National Antarctic Committee. The United Kingdom had strengthened its existing I.G.Y. Antarctic Subcommittee to deal with the problems of S.C.A.R.

(*b*) National reports on antarctic research planned for 1959 were summarized as follows:

Argentina will take over "Ellsworth" station from the United States and run a main scientific programme there, but limited studies will continue at "Base General Belgrano". Other Argentine antarctic bases will continue to operate as before.

Australia will continue operations at Macquarie Island, Mawson and Davis. In addition they will take over "Wilkes" station from the United States in February 1959. Ice sheet traverses will continue from Mawson for one more summer, then will be transferred to "Wilkes" station.

Belgium will continue to operate its Antarctic station during 1959.

Chile. The 1958 bases will continue in operation, and "Luis Risopatron", which was destroyed by fire in March 1958, will be rebuilt. Further investigations in geomagnetism, cosmic rays, geology, chemistry, biochemistry and bioclimatology are planned.

France. The inland station "Charcot" will be closed at the end of the I.G.Y. but "Dumont d'Urville" will continue to operate, with some small reductions in the programme.

Japan will reoccupy "Syowa" in February 1959 and leave a wintering party of 12 to 15 men. The party will study aurora and airglow, cosmic rays, geomagnetism, ionospheric physics, meteorology, glaciology, seismology.

New Zealand will continue operations at "Scott Base" and, jointly with the United States, at "Hallett" station on a modified basis. During the summer of 1958–59 biological, geological, surveying and oceanographic surveys will also be carried out.

Norway will continue the present scientific programme at their Antarctic base during 1959.

South Africa will continue to work on Tristan da Cunha and Marion Islands, and on Gough Island subject to agreement with the United Kingdom. They would welcome co-operation in putting a base on Bouvetøya and would like to send one or two meteorologists to help in an Antarctic coastal station. All above proposals are tentative.

United Kingdom. At Halley Bay research will continue in the most important scientific disciplines, but the programme is not fully decided. Extensive topographical and geological surveys will continue in the Graham Land region and eight existing Antarctic bases will continue their programmes.

United States will continue to operate the "Amundsen–Scott", "Byrd" and "McMurdo" stations, and "Hallet" station in co-operation with New Zealand. They are also prepared to help at "Ellsworth" station and "Wilkes" station. Ice sheet traverses would continue including one on to the Victoria Land plateau.

In addition, the "Little America V" station will be kept open as a logistics and supply base in support of United States antarctic research. The United States National Academy of Sciences is considering the question of further scientific investigations at "Little America V".

U.S.S.R. will continue work at existing bases. "Pionerskaya" will be closed

in January 1959, while there will be some reduction of work at "Oazis". It is hoped to move "Sovetskaya" to the Pole of Inaccessibility in October or November 1958. Ice sheet traverses will continue, including one from "Vostok" to the South Pole and back to "Sovetskaya". It is intended to establish small bases south of the Bellingshausen Sea and in Dronning Maud Land. These will study glaciology and surface meteorology and will assist in traverses which are planned to cross the Antarctic in the future. Oceanographical work will continue in the Bellingshausen Sea and in the region of the Antarctic Convergence to the north, and along the coast of Dronning Maud Land.

(*c*) For the purpose of S.C.A.R. it was agreed that the "Antarctic" shall be bounded by the Antarctic Convergence. Certain subantarctic islands, listed below, may be included in S.C.A.R.'s area of interest even if they lie outside the Antarctic Convergence:

Île Amsterdam	Prince Edward Islands
Îles Crozet	Île St Paul
Gough Island	South Georgia
Îles de Kerguelen	Tristan da Cunha
Macquarie Island	

(*d*) Three Working Groups were formed. Group I. Biology, physiology and oceanography, under L. Zenkevitch. Group II. International co-operation and publications, under G. R. Laclavère. Group III. Weather Central and studies of the atmosphere, earth and ice, under H. Wexler. Reports from the Working Groups were read later in the meeting. Arising from the report of Working Group III the following resolutions were passed:

(1) Weather Central. The importance of the continuance of an international Weather Central was recognized and it was suggested that it should be transferred to one of the countries in the southern hemisphere. It was recommended that Australia and New Zealand should consider the establishment of an international analysis centre in one of these two countries, and should submit a proposal to S.C.A.R. before 30 September 1958;

(2) that the mother–daughter communications network established in the Antarctic during the I.G.Y. be maintained and strengthened to ensure more effective and rapid collection of meteorological data within Antarctica;

(3) that additional radioteletype facilities be established in Antarctica to speed up the two-way flow of data between Antarctica and meteorological centres in the southern hemisphere;

(4) the W.M.O. be requested to recommend how southern hemisphere communication networks can be strengthened to enable complete and speedy exchange of data between all southern hemisphere countries;

(5) that a continuing Working Group on Antarctic communications be constituted under S.C.A.R. to include a communications expert, experienced in Antarctic communications, from each country involved in Antarctic work, and a communications expert from the W.M.O., to further the co-ordination of communications for the Antarctic region, including the collection and distribution schedules for meterological and other scientific data.

While there was general agreement about the aims of these resolutions, there was not complete agreement about the best methods to be followed. The following resolution was therefore approved:

"The Executive Committee is instructed to take appropriate action on radio-communication problems and to inform all members of S.C.A.R."

(*e*) A message of greeting was sent to all Antarctic stations from the Committee.

(*f*) Publications. It was agreed that the Committee should publish a special bulletin containing a factual record of S.C.A.R. activities. Also that the Committee would not make use of the I.C.S.U. editorial service, but that the bulletin would be published by the Scott Polar Research Institute in England and the Arctic and Antarctic Research Institute, Leningrad. The bulletin will appear as a separate section in the journals of these Institutes, and also be available as a reprint. Material in the bulletin will be free of copyright. Members of S.C.A.R. were asked to submit material for the bulletin to the Scott Polar Research Institute, Cambridge, England.

(*g*) Cartography. The Secretary was instructed to compile a map of Antarctica showing the past and future cartographic activities of member-nations from information supplied by them.

The formation of a Working Group was approved to

(1) study ways and means of producing a map of Antarctica on the scale of 1:3,000,000,

(2) examine the possibilities of co-operation by various nations in producing the map, and

(3) prepare specifications to ensure all possible conformity in maps produced by different agencies. One member from each nation is to serve on this Working Group of which G. R. Laclavère will be chairman. H. Wexler agreed to produce a catalogue of all available published maps of Antarctica.

(*h*) International co-operation. The following resolutions were passed:

(1) It was recommended that exchange of scientific personnel, as during the I.G.Y., should be continued as a general policy, subject to bilateral agreement in every case;

(2) recognizing that the integration of geological and glaciological knowledge gained from different parts of Antarctica may be impeded by differences in nomenclature, S.C.A.R. should encourage the interchange of field geologists and glaciologists working in different regions of the continent;

(3) it was recommended that exchange of scientific documents, including maps, should be continued as a general policy as during the I.G.Y.;

(*i*) a verbal statement was received from Poland announcing the intention to mount an antarctic expedition during the southern summer of 1959–60: (written confirmation was received after the meeting);

(*j*) the presence of representatives of S.C.O.R. and W.M.O. was welcomed and hope was expressed for future close co-operation with these bodies;

(*k*) future meetings of S.C.A.R. It was agreed that it was desirable for S.C.A.R. to meet annually during the northern hemisphere spring to enable

countries to put new plans into operation in the Antarctic during the following year.

The next meeting was arranged to be held in Canberra after the symposium on Antarctic meteorology to be held in Melbourne in March 1959. The proposal to hold an Antarctic symposium in Buenos Aires in November 1959 was welcomed.

(*l*) The President thanked the Academy of Sciences of U.S.S.R. and the Soviet delegates for enabling the meeting to be held so successfully in Moscow. Dr Somov thanked delegates for coming to Moscow and hoped that the same excellent spirit of co-operation would prevail at future meetings of S.C.A.R.

Constitution of S.C.A.R.

Membership

S.C.A.R. is a Special Committee of I.C.S.U. charged with furthering the co-ordination of scientific activity in Antarctica, with a view to framing a scientific programme of circumpolar scope and significance. In establishing its programme S.C.A.R. will take care to acknowledge the autonomy of other existing international bodies.

Nominations to the Committee are as follows:

(*a*) Each country actively engaged in Antarctic research is represented by one scientific delegate

(*b*) International Scientific Unions federated in I.C.S.U., which have indicated their interest in Antarctic research, may appoint one representative each

(*c*) Other international organizations and Special Committees of I.C.S.U. may be invited to send observers.

Constitution

(*a*) S.C.A.R. nominates an Executive Committee from amongst its own members consisting of a President, a Vice-President and a Secretary, each elected for a term of three years and each eligible for re-election. These nominations are subject to confirmation by the Bureau of I.C.S.U.

(*b*) The Executive Committee is responsible to I.C.S.U. for the co-ordination of the scientific programme adopted by S.C.A.R.

(*c*) S.C.A.R. will invite the formation of National Antarctic Committees in the participating countries to frame and carry out an operational programme designed to implement the general scientific programme formulated by S.C.A.R.

(*d*) S.C.A.R. may appoint *ad hoc* committees for the examination of special problems

(*e*) The Executive Committee, with the approval of S.C.A.R., will submit its budget requests to I.C.S.U. including an estimate of the scale of contributions required from the participating countries to maintain the central administration. For this purpose a Finance Committee of three members will be appointed consisting of the Treasurer of I.C.S.U. *ex-officio*,

and two members, not members of the Executive Committee, to be appointed by S.C.A.R. The Secretary of S.C.A.R. will act as adviser to the Finance Committee

(*f*) The expenses of the Executive Committee of S.C.A.R. will be defrayed by S.C.A.R., but the expenses of all other members will be the responsibility of the National Committees and Scientific Unions

(*g*) Expenditures incurred by S.C.A.R. will be subject to control by the Treasurer of I.C.S.U.

(*h*) In addition to his normal duties the Secretary of S.C.A.R. will keep the Secretary General of I.C.S.U. fully and promptly informed of all activities.

Scientific investigations recommended by S.C.A.R.

The following scientific investigations were recommended at the first and second meetings of S.C.A.R. Any corrections or suggested additions should be sent by National Committees or National Delegates to the Secretary of S.C.A.R.

Meteorology

A. General

(*a*) The heat and moisture budgets of the Antarctic atmosphere and ice sheet

(*b*) The mean air circulation in the Antarctic regions

(*c*) Local effects in the Antarctic, particularly in the vicinity of the coastline

(*d*) The nature and extent of broad-scale meteorological processes over Antarctica and the remainder of the Southern Hemisphere

(*e*) The mutual influence between pack ice and the character and motion of the air

(*f*) The air flow in the friction layer over the Antarctic continent

(*g*) The Antarctic stratosphere and the exchange of air between the stratosphere and troposphere as shown by such atmospheric tracers as ozone.

A ten year period of observations is desirable.

B. Synoptic observations. The greatly increased networks of meteorological stations established in Antarctica during the I.G.Y. has enabled a reasonably detailed knowledge of weather processes over the Antarctic to be obtained for the first time, and every effort should be made to maintain the present scope of surface and upper air observations, and to increase the network where possible.

The areas deficient in observations are:

(*a*) the area bounded by lats. 45° S. and 60° S. and longs. 45° W. and 35° E.

(*b*) the area bounded by lats. 45° S. and 65° S. and longs. 80° W. and 150° E.

(*c*) the area bounded by lats. 45° S. and 65° S. and longs. 80° W. and 170° W.

(*d*) the antarctic coastal area between longs. 80° W. and 150° W. and in the vicinity of longs. 155° E., 125° E. and 10° E.

(*e*) and the areas centred over the following positions:

lat. 80° S., long. 0°	lat. 75° S., long. 130° E.
lat. 75° S., long. 30° E.	lat. 80° S., long. 80° W.
lat. 75° S., long. 60° E.	

As W.M.O. considers that the greatest need for an increased network is in the ocean areas within the field of interest of S.C.A.R., every effort should be made to secure surface and upper air observations from islands and ships in these areas.

The method of obtaining temperature for use in pressure reduction in the Antarctic should be standardized through the normal W.M.O. machinery. In particular, the restrictions imposed by W.M.O. on the reduction of pressure should be observed, the preferred reduction levels being 850 or 700 mb. as appropriate.

C. Special observations

(*a*) Continuous measurements of the ozone content of air at the surface of the earth

(*b*) Air photography of surface features, such as sastrugi, to obtain wind direction in areas where regular observations are not made

(*c*) Aerial determinations of the albedo

(*d*) Micrometeorological and meso-meteorological measurements

(*e*) Atmospheric chemical and precipitation content determination

(*f*) Morphological determinations of falling snow crystals and of condensation nuclei

(*g*) Observations of noctilucent and mother-of-pearl clouds

(*h*) Aircraft flying over or near the Antarctic should carry out the recommended meteorological observations and should report them promptly

(*i*) Traverse parties should measure the temperatures of the ice down to 15 m., as the temperature at this depth is very similar to the mean annual temperature at the surface

(*j*) S.C.A.R. welcomes the efforts already in progress to obtain total ozone content and urges the International Ozone Commission and the W.M.O. to devise schemes whereby the inter comparison in the Antarctic of the standards used for such measurements can be effected.

D. Atmospheric nuclear radiation. Stations engaged in measuring the radio-activity of air and precipitation should carry that work on as far as possible after the I.G.Y. Other stations are invited to initiate such a programme.

E. Rockets. Rocket-sounding programme should be enlarged to cover the winter season, measuring temperatures and winds up to 80 km., at the rate of one per week. Rocket-borne experiments to greater altitude for studies of high atmospheric conditions and parameters of particular interest for the south polar cap.

F. Weather Central. S.C.A.R. recommends that Australia and New Zealand should consider the possibility of the establishment of an international analysis centre in one of these two countries.

Ionosphere

(*a*) Vertical incidence sounding. The programme should follow the principles suggested in the 1958 Edinburgh report of the U.R.S.I.–A.G.I. Committee. At least two stations on the Antarctic continent should be Class F (full) and the remainder should be Class P (patrol) stations and as many as possible should be continued for at least another half solar cycle.

(*b*) Special observations. (1) Measurements of atmospheric radio noise should be continued for a full solar cycle at a minimum of two stations. (2) Special studies should be made on whistlers and very low frequency emissions, absorption and scatter and low level echoes which may be peculiar to the southern auroral zone or polar cap. These studies should be co-ordinated with special studies in other disciplines concerning the high atmosphere.

Auroral physics

(*a*) The morphology of visible auroras, H and He emissions and H.F. radio scattering regions

(*b*) The sources of energy producing geomagnetic and ionospheric disturbances and auroras

(*c*) The nature of the agency causing excitation of auroral emission

(*d*) The composition and physical state of the upper atmosphere.

Observational programmes should continue at stations well distributed in Antarctic regions using the several techniques available, such as visual observing, all-sky photography, photometric, spectographic, radar and parallactic photography.

Attention is drawn to the possibility of gaining new information on the geomagnetic field in regions far from the earth by comparing Arctic and Antarctic observations on V.L.F. radio emissions, auroras and cosmic ray variations. Such comparisons may also contribute to understanding the mechanism of production of auroras. This possibility should be considered before fixing the positions of any new Antarctic stations.

Geomagnetism

(*a*) A geomagnetic observatory programme with base line control should be maintained at several stations as part of the global network. Geomagnetic variation recordings should be encouraged at all stations involved in upper atmosphere studies and the recording and analysis should be designed to meet these requirements. The importance of low sensitivity recording is emphasized

(*b*) A geomagnetic survey of the permanent field in the Antarctic area (continent and southern seas) should be carried out and co-ordinated with the projected World Magnetic Survey.

Cosmic Rays

(*a*) Sources and mechanism of generation of cosmic rays

(*b*) Cause of changes of cosmic ray intensity which appear to be associated

with changes in the distribution of matter and/or magnetic fields in interplanetary space

(*c*) Form of the geomagnetic field at great distances from the earth.

These should be the subject of long-term observances from well-distributed stations.

Geology

In addition to classical studies special attention should be directed to:

(*a*) The terrain beneath the ice as revealed by seismic studies

(*b*) Post-glacial and/or Quaternary geology at coastal stations

(*c*) Paleoclimatic studies

(*d*) Paleomagnetic studies

(*e*) Submarine geology.

Glaciology

(*a*) Thickness, structure and volume of inland ice as revealed in seismic soundings. The bedrock beneath the ice should also be investigated by seismic shooting

(*b*) Regime observations

(*c*) Annual stratification of firn to establish climatological significant precipitation records

(*d*) Structure of the inland ice sheet and ice shelves as revealed from deep pits and deep bore holes, particularly near the top of ice caps

(*e*) Variations of velocity of propagation with depth in typical ice areas should be made by long reversed refraction shooting and also shooting in deep bore holes. This might also aid in the study of propagation laws as a function of depth, temperature, stress, etc.

(*f*) The application of indirect techniques to determine the nature of the bedrock under the ice by the use of electrical methods, etc.

Geomorphology

Studies of land forms with particular attention to the geological role of an inland ice sheet past and present.

Cartography

A comprehensive, co-ordinated mapping programme should have high priority.

S.C.A.R. will consider in detail how this programme can be co-ordinated.

Seismology

There are two principal problems of Antarctic seismological research:

(*a*) to use local earthquakes and explosions to infer Antarctic crustal structure, and

(*b*) to use distant earthquakes both to obtain evidence on Antarctic structure and also on the earth's deeper structure. The establishment of

first class seismological observatories in the Antarctic can fill in an important global gap.

The setting up of new seismological observatories in the Antarctic is largely experimental. Relevant factors include the suitability of particular sites (difficulties with microseims, etc.), the human difficulties, and the as yet not fully known local seismicity. The present number of seismological observatories in the world is about 700. There should ultimately be not less than a corresponding number, determined on the basis of geographical area, in the Antarctic. Stations should normally be uniformly distributed, but special problems and features of local seismic activity may make this undesirable in some areas. Each station, in addition to having an adequate set of good seismographs, should have assured absolute time marks recorded on the seismogram so that absolute time can be read to less than a second. Stations should in due course become permanent.

Gravity

(*a*) The determination of gravity for the purpose of utilizing the data for geodesy as well as for the study of the upper layers of the earth's crust, and for solving some problems of glaciology
(*b*) Extension of the world networks of basic gravity points to the Antarctic
(*c*) Measurement with pendulum instruments as well as gravimeters with small or constant drift.

Vulcanology

To begin with, vulcanological studies are likely to emerge from broader geological studies, and then become more specialized as development continues. The Antarctic borders on the Pacific Ocean, from round the rim of which comes 85 per cent of the total energy released in earthquakes. It is therefore important that great attention be paid to the seismic and vulcanological problems of the area.

Oceanography

(*a*) Study of bottom relief and sediments in the shallow shelf zone of the Southern Ocean around the continental shelf as well as in oceanic regions adjacent to the slope
(*b*) Study of the Antarctic coastal current
(*c*) Study of ice in the Southern Ocean by systematic sea and air observations. All expeditions using aircraft should make systematic sea-ice observations from aircraft throughout the year, and should organize the exchange of data with other expeditions using W.M.O. codes
(*d*) Study of the Antarctic Convergence zone in the Southern Ocean. Here multiple sections across the Antarctic Convergence are specially recommended (oceanographic observations and measurements of the surface currents should be made not far from the frontal line). It is desirable to carry out synchronous observations in the zone of the Antarctic Convergence, employing for this the greatest possible number of

oceanographic vessels and expedition ships working in the Antarctic. It is recommended that National Committees be asked to submit to S.C.A.R. the working plans of these investigations by 30 September 1958

(*e*) Study of the deep currents in the Southern Ocean, especially in the field of the western wind drift, using the method of absolute water age determination

(*f*) Study of tides and tidal current changes in the coastal regions of Antarctica. It is highly desirable to make a cycle of at least one full year, and, if possible, continuous observations of sea-level fluctuations at shore stations in the Antarctic

(*g*) Systematic seasonal deep observations along the following sections should be considered the minimum requirement:

(*a*) South from Cape Town along long. 20° E.

(*b*) South from New Zealand along long. 165° E.

(*c*) Across Drake Passage.

It is desirable to increase the number of standard sections. It is recommended that the National Committees submit to the Secretary of S.C.A.R. working plans for these investigations.

Marine biology

(*a*) Biological quantitative and qualitative composition of the Antarctic water population. Studies of primary production involving pigments, C^{14}, O_2, etc.

(*b*) Distribution of plankton mass (primarily phytoplankton and euphausids, their eggs, larva stages and Copepods) as well as of the conditions (physical and chemical) of formation in different seasons.

(*c*) A check against the data from these should be attempted by analysing stomach contents from as large a range of vertebrates as possible.

(*d*) Biochemistry of depigmented fish (Nototeniformes order).

(*e*) Studies of seals, penguins, lichens and of the invertebrate fauna associated with them should be included. The ecology and life histories of the neritic marine fauna should also be studied.

Biology

A general biological programme is at present being considered.

Physiology

A programme of medical research is at present being prepared for consideration by S.C.A.R.

CORRESPONDENCE

BREEDING AND MAINTENANCE OF SLEDGE DOGS

I should like to question a number of Mr Taylor's statements in his article "The breeding and maintenance of sledge dogs" (*Polar Record*, Vol. 9, No. 56, 1957). Like him I have worked with F.I.D.S. sledge dogs and, in addition, have spent a winter with the West Greenlanders and two years with the British North Greenland Expedition where we often sledged with the Danish Sledge Patrol and various Danish and Norwegian trappers.

1. Mr Taylor states that "there is considerable agreement that the husky ...is descended in the main from the wolf". I suggest that there is also considerable agreement that the contrary is the case, and that dogs are not descended from wolves at all.

2. I feel he gives a wrong impression of the weight of huskies when he states "...the weight of northern huskies is about 80 lb.". In fact it varies considerably from district to district between about 60 and 100 lb.

3. The last sentence of "Changes in the F.I.D.S. dogs" is a misquotation. Alan Reece states that the dogs the Norwegian–British–Swedish Antarctic Expedition obtained from Spitsbergen were of *Canadian* origin, not Greenlandic. He also says that the West Greenland and F.I.D.S. dogs were much the same weight, which seems surprising, but was probably due to the F.I.D.S. dogs in question being of poor quality.

4. Although the "health of dogs at base" may have been "excellent" in general (p. 432), Mr Taylor does not mention the large percentage of accidental puppy deaths, namely, one-third of the puppies of the ten litters for which he gives figures in his official report. I suggest that this may have been due to the type of indoor kennel at Hope Bay which, contrary to recommended practice, has no outdoor opening for the bitch. However, the whole question of puppy deaths is very debatable.

5. Sledging methods. "Whips are rarely carried", Mr Taylor says. No wonder "some leaders were poor and inexperienced" and no wonder Mr Taylor had to have someone ski-ing ahead of his team for most of his only long sledge trip. I have just spent one winter with F.I.D.S. and the use of whips for driving sledge dogs is becoming common again. I am convinced that it is far easier to train a new leader, or a newly formed team or a young dog with the aid of a whip than without one, and I believe that recent practices in F.I.D.S. have proved this conclusively. There is no need to use a whip cruelly, its main use is for steering; once a leader and/or team is well trained, the whip is hardly necessary. Bingham and Croft both make similar statements. Admittedly, the type of whip recently supplied to F.I.D.S. was not easy to handle, but this matter is being seen to.

6. I presume that there was a reason for having teams which "could be allocated to anybody", but in my experience the most efficient 'crack' team

is produced by being driven by the same man all the time, and this agrees with Base E practice in 1946–49, when, I believe, a particularly high standard of British dog-driving was reached. There is no reason why each team should not be "of nearly equal strength".

7. The age to start training puppies. Various people have recommended different ages, between 6 and 12 months, due, I suspect, to confusion about what "training" means. Training dogs to obey orders and run in their correct place, i.e. *mental* training, should be started in my opinion at six months. This agrees with Greenlanders' techniques, which result in a high standard of obedience. The *physical* training needs careful control; in order to build up the dog's pulling muscles and general fitness without impeding his normal growth, he should not be over-exercised to begin with. I suggest an hour's run two or three times a week in the seventh month, two hours in the eighth month and so on, working up to short proper journeys round about eleven and twelve months. This is definitely less exercise than the usual Greenlander practice and in that respect may partially account for the weight difference referred to in (2) above.

8. "Dogs suffered from boredom while on the spans." If dogs are out sledging for three-quarters of the year as they should be, I cannot believe that their time on the span will weaken their mental stamina. However, I do think it would be a good thing to put a dog team into a pen occasionally at a base (with the driver standing by!) for another reason: to let the dogs establish internal discipline, the order of seniority from boss dog downwards. Once this is firmly established, dog fights are far less frequent and the team in general is far more controllable. I have sledged hundreds of miles with the Danish N.E. Greenland Sledge Patrol, who always keep theirs loose, and I noticed no difference in mental stamina of the dogs.

9. It is very difficult to pin down a dog's "final" weight. It varies with the dog's age (from one year onwards), the season of the year, the quantity and quality of his food, the exercise he is, or has been, taking, whether there are bitches on heat nearby, the condition of his coat, whether he has any moisture in his coat when he is weighed, etc. Also a dog's weight/age graph flattens out between 7 and 18 months so that it is difficult to conclude anything definite there. However, in my experience, dogs reach full weight much earlier than Mr Taylor suggests, namely, around 9 months, and I have figures to support this statement. In fact, the dogs quoted in his Fig. 1 had a final weight of nearer 89 lb. than 95 lb., and hence it proves my point.

10. Colour. The F.I.D.S. present dominating strain of black-and-white dogs is unusual in my experience (65 per cent of the dogs at Base W are that colour). Such colours were in a minority in Jakobshavn in 1951, north east Greenland 1952–54 and Spitsbergen in 1956; the dominating colours there were a type of brindle or dirty browny-grey, with all-red and all-black running second place.

11. Mr Taylor states that his dogs suffered boredom on the Larsen Ice Shelf, and he had to have someone ski-ing ahead most of the time. The recent magnificent air-supported journeys of the New Zealanders in the Antarctic

prove that dogs will never be bored if they are really well fed—a fact that any Arctic trapper knows. However, on the ration that Mr Taylor's dogs had, their performance still sounds comparatively poor, which I respectfully suggest was due to the inadequacy of the lead dogs and wrong methods of training and driving.

To sum up my personal views:

(*a*) Dogs should begin to be trained at 6 months.

(*b*) One team should always be driven by the same man.

(*c*) The whip should be used, especially for training.

(*d*) Teams should be in the field for three-quarters of the year. (Glen describes how his dogs on his 1935–36 expedition were used from August to August).

(*e*) Every team should have a properly trained leader dog who is not used to following a man or another team.

(*f*) Every team should have a reserve leader.

I believe that any "psychology" involved in dog driving is in the general training of the teams and the relationship between the driver and his dogs, and not in Mr Taylor's "three grades of sledge dogs". So far as the intelligence of a husky is concerned, terms are relative; I think that most huskies are stupid and it is probably just as well. The tiny quantity of sense needed by a leader to obey about four very simple orders surely hardly counts as intelligence. Most domestic dogs could learn them far quicker than a husky does.

12. I agree with Mr Taylor that mechanical and dog transport are each superior to the other in different conditions, though the validity of some of the figures in his Tables 2 and 3 is open to question. To take one example only, the term "payload" normally refers to the useful load a vehicle can carry not including its own fuel. In that case the average payload of a dog team should be about 250 lb. and that of the towed sledge of a Weasel "nil" (for full range). The figure for the Weasel is correct as fuel is not usually carried in the vehicle itself.

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4 *September* 1958

OBITUARY

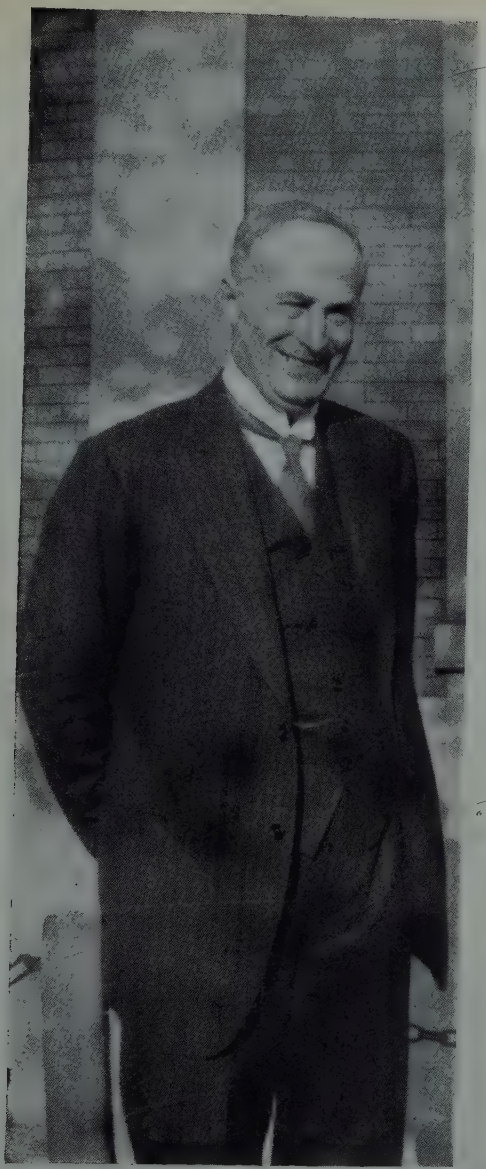
Dr Henryk Arçtowski, the distinguished meteorologist, was born in Poland in 1871 and died in Washington on 20 February 1958. He was educated in Belgium and Paris and also studied in London and Zürich. He joined the Belgian Antarctic Expedition, 1897–99, and was in charge of the geological, oceanographical and meteorological programme. He was connected with the Belgian Weather Service until 1909 and then became chief of the Science Division of the New York Public Library. In 1920 he returned to Poland to become professor of geophysics and meteorology at the University of Lwow, and was attending a conference of the International Union of Geodesy and Geophysics in Washington when Poland was invaded at the beginning of the Second World War. After a period in England he was appointed to a position in the Smithsonian Institution from which he retired six years ago.

Bror Åke Campbell, the Swedish ethnologist, was born in Linköping on 1 May 1891 and died on 14 October 1957. He obtained his doctorate in 1929 and in 1952 received the title of professor. He was also the secretary general of the International Association for European Ethnology and Folklore. Campbell, who was head of the folklore department of Landsmåls- och folkminnesarkivet i Uppsala from 1930 and docent in Scandinavian ethnology at Uppsala Universitet from 1938, was interested in the study of cultures in Lapland, especially the relationship between Swedish settlers and Lapp nomads; *Från vildmark till bygd: en etnologisk undersökning av nybyggarkulturen i Lappland före industrialismens genombrott* (Uddevalla, Hermes, and København, Munksgaard, 1948) deals with this subject. He also wrote on the place of the Lapps in Swedish popular tradition.

Sir Douglas Mawson was born in Bradford, Yorkshire, on 5 May 1882 and died in Adelaide on 14 October 1958. He accompanied his parents to Australia as a boy and graduated at the University of Sydney. In 1905, after accompanying a pioneer geological expedition to the New Hebrides, he was appointed lecturer in mineralogy and petrology at the University of Adelaide. He was Professor of Geology at this university from 1920 to 1952.

In 1907–09 he joined Shackleton's British Antarctic (*Nimrod*) Expedition to the Ross Dependency. He was a member of the first party to climb Mount Erebus and also of the party of three, under Sir Edgeworth David, which first reached the South Magnetic Pole. He organized and led the Australasian Antarctic Expedition, 1911–14, which discovered and explored King George V Land and Queen Mary Land, claiming them for the British Crown. Shore parties wintered at Cape Denison and on the Shackleton Ice Shelf, and very extensive scientific investigations were carried out, both on the Antarctic mainland and at a third station on Macquarie Island. It was during this expedition that Sir Douglas made his greatest journey. He was sledging with X. Mertz and B. E. S. Ninnis 280 miles from the Cape Denison base when the latter was lost down a crevasse, together with his dog sledge and most of the provisions. The two survivors struggled to return, but Mertz died 100 miles from base, and Mawson returned alone and in extreme privation, with illness and weather keeping him for a week in an ice cave only five miles from his destination. On his return to Australia he was knighted and awarded the Founder's Medal of the Royal Geographical Society. His published narrative of this expedition, *The Home of the Blizzard* (London, 1915), will always remain one of the great polar classics.

During the First World War he served in Europe, then returned to Adelaide University, where he devoted his energies to the preparation and publication of the



SIR DOUGLAS MAWSON

scientific reports of his Antarctic expedition. In 1929–31 he organized and led the British, Australian, New Zealand Antarctic Research Expedition for two summer voyages in the *Discovery*. MacRobertson Land was discovered; also, from the air, the Banzare Coast and Princess Elizabeth Land. The boundary between Australian and Norwegian interests was fixed and the regions which were later to become the Australian Antarctic Territory were formally claimed. It was very largely due to his tireless persuasion that the Australian Government created the Australian Antarctic Territory and has continued to take an increasingly active interest in the Antarctic.

In addition to polar journeys Sir Douglas led a number of significant geological expeditions in Australia. He was a polar explorer of heroic stature, yet his greatest achievements were probably in other fields. He was first and foremost a scientist, as ready to carry out geological and mineralogical investigations in Australia as in Antarctica; everything else during an expedition was incidental to his main purpose.

Sir Raymond Priestley writes of him:

> I first got to know Douglas Mawson in January 1908 as the *Nimrod* wallowed south through what seemed to be an unending succession of westerly gales, each worse than its predecessor. With one exception we of the shore party were seasick; we all "gave up", but he at once returned to the wardroom and repeated his meal. Mawson liked warmth. One day, after a 20-hour spell humping cargo, we were resting when a sudden blizzard caused the ship to break away from her moorings. Douglas was sleeping in the engine room with his long legs disposed across the cross-head of *Nimrod*'s engine. When she broke loose the engines were started and an hour later he was found still asleep with his legs rising and falling as the piston-head went up and down.
>
> Nothing daunted that lean, hungry-looking Australian, whose determination and grit were only matched by the singlemindedness with which he pursued his own and his leader's aims.

Andrew L. Nelson was born at Clydebank and died in New Jersey on 26 August 1958 at the age of 54. Between 1929 and 1935 he served the Discovery Committee as navigator, first officer and finally captain of *Discovery II*. In addition to these duties he was responsible for organizing surveys of the South Sandwich Islands, the South Orkney Islands and part of the South Shetland Islands. He was joint author, with Dr Kemp, of a report on the South Sandwich Islands in *Discovery Reports*. He was an able navigator, and an accurate scientific observer, his sounding charts have contributed much to what is known of the bottom topography of the Southern Ocean. During the Second World War he served in the Royal Navy and was later employed as an oceanographer at Lamont Geological Observatory, a division of Columbia University.

Helge Petersen, director of Det Danske Meteorologiske Institut from 1942 to 1956, died on 29 September 1958 at the age of 72. He was the author of a number of papers on Greenland's climate and meteorological organization, and was also a member of Kommissionen for Videnskabelige Undersøgelser i Grønland.

Carl William Thalbitzer, the Danish philologist and ethnologist, was born in Helsingør in 1873 and died on 18 September 1958. He studied languages at the University of København and in 1900 paid the first of a long series of visits to Greenland, including a winter at Jakobshavn and one at Angmagssalik. He travelled widely among Greenlanders and became an authority on the language, customs and culture of the people. In 1926 he became professor of Greenlandic language and culture at the University of København. He published numerous works on every aspect of Greenlandic life including "A phonetical study of the Eskimo language" (*Meddelelser om Grønland*, Vol. 31, 1904) and a large part of "The Ammassalik Eskimo" (*Meddelelser om Grønland*, Vol. 39, 1914, Vol. 40, 1923 and 1941) which he also edited.

RECENT POLAR LITERATURE

This bibliography has been prepared by R. J. Adie, Terence Armstrong, T. H. Ellison, Amorey Gethin, J. W. Glen, W. B. Harland, H. G. R. King, Brian Roberts and Ann Savours. Its main field is the polar regions, but it also includes other related subjects such as "applied" glaciology (e.g. snow ploughs and ice engineering). For the literature on the scientific study of snow and ice and of their effects on the earth, readers should consult the bibliographies in each issue of the *Journal of Glaciology*. For Russian material, the system of transliteration used is that agreed by the U.S. Board on Geographic Names and the Permanent Committee on Geographical Names for British Official Use in 1947 (see *Polar Record*, Vol. 6, No. 44, 1952, p. 546). For reasons of economy it has been possible to print only a selection of the total literature catalogued. A classified bibliography is maintained at the Scott Polar Research Institute which is at the disposal of all readers.

Reprints of "Recent Polar Literature", from Nos. 37/38 onwards, can be obtained separately (to allow references to be cut out for pasting on index cards) from the Institute, price 2*s*. 6*d*. for two reprints. Copies will be sent without charge to organizations with which the Institute maintains exchange arrangements and which notify their wish to receive them. Readers can greatly assist by sending copies of their publications to the library of the Institute.

To increase the usefulness of the bibliography entries have been arranged provisionally under subject headings in classified order according to the Universal Decimal Classification. When circumstances permit the decimal notation will be included, together with a key.

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[Northern Sea Route] Navstrechu arkticheskoy navigatsii [Towards the arctic navigation season]. *Morskoy Flot* [*Merchant Fleet*], 1958, No. 5, p. 32. [Shipping preparations for 1958 season on Northern Sea Route.]

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Antarctic

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[Antarctic : Territorial Claims] *International Court of Justice, Pleadings, oral arguments, documents, Antarctica cases (United Kingdom v. Argentina; United Kingdom v. Chile). Orders of March 16th, 1956: removal from the list.* [s'Gravenhage, International Court of Justice, 1956?]. 114 p. map. 24½ cm. (Sales no. 183.) [Text of United Kingdom's case against Argentina and Chile relating to conflicting territorial claims. In English and French.]

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[Survival at Sea] *Meteorological and oceanographic factors relating to Antarctic air-sea rescue operations and human survival.* Washington, D.C., U.S. Navy Hydrographic Office, 1957. vii, 10 p. 57 diagrs. 27 cm. 75*c.* (H.O. Pub. 16,659). [Meteorological and oceanographic background information for route between New Zealand and McMurdo Sound, Antarctica.]

[Antarctic : Place-Names] *South Atlantic: official standard names approved by the United States Board on Geographic Names.* Washington, D.C., Office of Geography, Department of the Interior, 1957. [v, 55] p. (*United States Board on Geographic Names Gazetteer* No. 31). [Includes Falkland Islands, South Georgia, South Orkney Islands, South Sandwich Islands, South Shetland Islands, Bouvetøya, Tristan da Cunha, Gough Island.]

Knapp, W. H. C. *Antarctica: de geschiedenis van het geheimzinnige Zuidland.* Haarlem, De Erven F. Bohn N.V., 1958. 589 p. illus., map (in end pocket). 25 cm. [General account and history of exploration.]

SANTUCCI, LAERTE. Cartografía y fotogrametría argentina en la Antártida. *Revista Geográfica Americana*, Año 24, Vol. 41, No. 243, 1957, p. 2–33, maps. (Contribución del Instituto Antártico Argentino No. 16.) [Cartographic work and air photographic surveying carried out by Argentine Servicio de Hidrografía Naval in Falkland Islands Dependencies to 1955–56 season.]

[ANTARCTIC : CARTOGRAPHY] Contemporary cartography—Antarctica 1 : 10,000,000 zenithal equidistant projection. *Cartography* (Melbourne), Vol. 2, No. 1, 1957, p. 16–20, map. [Describes second edition of this map recently published by Division of National Mapping, Department of National Development, for Antarctic Division of Department of External Affairs, Australia. Specimen of map (in colour), showing Australian Antarctic territories.]

ROBERTS, BRIAN BIRLEY, *comp.* *Gazetteer of the Falkland Islands Dependencies: first supplement.* London, Foreign Office, 1958. 7 p. 34 cm. [Lists 300 new place-names.]

USHAKOV, P. V. Subantarkticheskiye ostrova Makkuori i Kergelen [The sub-antarctic islands of Macquarie and Kerguelen]. *Priroda* [*Nature*], 1958, No. 3, p. 58–63, illus., maps. [General description, based on visit in 1956.]

CUMPSTON, JOHN. *Macquarie Island: a bibliography.* Cremorne, N.S.W., Stone Copying Company, 1958. [v], 32 leaves, map. 26 cm. (*Studies in Australian Bibliography*, No. 6). [Includes newspaper references; much material relates to sub-antarctic islands of New Zealand.]

MCGREGOR, P. M. Report on the sounding of Prion Lake, Macquarie Island, March 1953. *Commonwealth of Australia. Department of National Development. Bureau of Mineral Resources. Geology and Geophysics, Records*, 1953, No. 110, 2 p. map (folding). [Depths measured by Australian National Antarctic Research Expedition.]

ERRATA

The *Polar Record*, No. 59, May 1958

Page 161, line 12. *For* 1920 *read* 1928.

THIRTY-FIRST ANNUAL REPORT ON THE WORK OF THE SCOTT POLAR RESEARCH INSTITUTE

The General Board beg leave to publish the following Report which they have received from the Acting Director of the Scott Polar Research Institute on the work of the Institute for the year ending 31 July 1957.

Constitution. The new constitution of the Institute as set out in the Report of the General Board on the constitution of the Scott Polar Research Institute as a Sub-department within the Department of Geography (*Reporter*, 1956–57, pp. 430–36), which was approved by Grace 5 of 23 February 1957, became effective from 1 January 1957.

Research. Under the new constitution new appointments were authorized which were not, however, filled in the year under review. This made it difficult to initiate research. Sea ice studies have continued to take a leading place, with Dr Armstrong in general charge. Dr Roberts has continued his work on Antarctic history and place-names. Dr Swithinbank has spent the year in Canada, including a period aboard H.M.C.S. *Labrador* in the Arctic, in continuance of his ice probability analysis of Canadian arctic waters undertaken under contract with the Defence Research Board in Ottawa. Mr J. A. Heap of the Falkland Islands Dependencies Scientific Bureau has continued his study of ice in the waters of the Dependencies, and spent the southern summer of 1956–57 in the Weddell Sea aboard the *Magga Dan*.

Professor Adolf Hoel and Dr Kjeld Myklebust, both of Oslo, worked at the Institute in June 1957, examining manuscripts relating to the history of mining claims in Svalbard.

Professor A. L. Korn of the University of Hawaii, who is preparing a book on the Sandwich Island letters of Sophia Cracroft and Lady Franklin, worked at the Institute during July 1957.

Fritz Müller of the Versuchsanstalt für Wasser- und Erdbau, Zürich, worked in the library in March 1957 on permafrost problems which he had been studying in the Mackenzie delta and Greenland.

Staff. Dr Bertram resigned the Directorship on 31 December 1956.

Miss E. A. Woodhouse, temporary Library Assistant, left the Institute on 8 June 1957. She was succeeded by Miss J. A. Masterman on 16 June 1957.

Finance. During the year the Institute received the following sums, which are gratefully acknowledged.

H.M. Treasury grant-in-aid. The sum of £3250 was received on 12 February 1957 for the half-year October 1956–March 1957.

Australia. A donation of £398. 16*s.* 1*d.* (£A500) authorized by the Australian Cabinet was received on 24 May 1957.

Falkland Islands Dependencies Administration. An eighth annual subvention of £100 was made by the Governor of the Falkland Islands and was received on 2 January 1957.

South Africa. A donation of £200 from the South African Government was received on 12 October 1956.

New Zealand. A grant of £100 sterling was received from the New Zealand Government on 24 September 1956.

Publications. Since the last Annual Report was published three numbers of the *Polar Record*, Nos. 54, 55 and 56, have been issued, a total of 297 pages; also the Index to Volume 6. The Index to Volume 7 is in preparation.

Lectures. Lectures were given at the Institute during the Michaelmas and Lent Terms.

1956	
13 October	"Trans-Antarctic reconnaissance", by Dr V. E. Fuchs.
27 October	"Gough Island", by J. B. Heaney.
10 November	"Polar films".
24 November	"Sledge dogs", by R. J. F. Taylor.
1957	
26 January	"Alaska Fur Seals: A half century of international co-operation", by Dr V. B. Scheffer.
16 February	"Polar films".
2 March	"Birds and beasts of the Bering Sea", by James Fisher.

Friends of the Polar Institute. The membership has remained substantially the same during the past year and is now 271, representing a total subscription of about £400 a year. The continued generosity and support of the Friends is greatly appreciated.

Gino Watkins Memorial Fund. Many gifts have been made to the Fund, thus increasing the stock of equipment. Loans of equipment for use during the summer of 1957 were made this year to ten expeditions.

Visits. Miss A. M. Savours, with the help of a bursary from the British Federation of University Women, spent five weeks in Scandinavia in April–May 1957. She visited polar and other institutions in Copenhagen, Oslo, Tromsø, and Stockholm, and spent a fortnight in Lapland in the Kiruna–Kautokeino area.

Mr P. A. B. Gethin visited Sweden and worked in Göteborgs Stadsbibliotek during July 1957.

Museum. A special exhibition was opened on 21 May 1957 to introduce the Institute and its work to the University, of which it had recently become a sub-department. The exhibition was divided into two general sections, "Research in the Institute" and "Recent polar events". The Institute is indebted to the Directorate of Overseas Surveys for an exhibit illustrating the progress of the survey and mapping of the Falkland Islands Dependencies. The major part of the exhibition remained open to the public until 5 June.

Library. During the year, 3025 publications were added to the library. Of these, 575 were gifts, 271 were purchased and 2179 were received in exchange for the *Polar Record.* These totals include 469 periodical and serial publications. Of the 1163 maps and charts received, 95 were gifts, 77 were purchased and 991 were received in exchange.

The library has benefited by a bequest of the late Professor Robert Neal Rudmose Brown, who left all his books and pamphlets on polar exploration to the Institute. The Institute wishes to thank his daughter, Mrs J. B. Brown of Sheffield, for presenting additional manuscripts, photographs and maps not specified in the bequest. These manuscripts constitute a valuable primary source for Spitsbergen history.

The manuscript collection has also been enriched by two other bequests: the papers of the late Admiral Sir Reginald Skelton, R.N., of the British National Antarctic Expedition, 1901–04, and those of the late Maxime Charles Lester, who wintered in Graham Land with T. W. Bagshawe in 1921–22.

The year's purchases include a scarce edition of Gerret van Sante's *Alphabethische naam-lyst van alle de Groenlandsche en Straat-Davissche commandeurs die zedert het jaar 1700 op Groenland, en zedert het jaar 1719 op de Straat-Davis, voor Holland en anders provincien, hebben gavaaren...* Te Haarlem, Johaness Enschede, 1770. This is a list of Dutch expeditions to Greenland waters and Davis Strait in the eighteenth century, continued to the mid-nineteenth century by manuscript additions.

The Institute wishes to thank Miss C. K. Golding of Exeter, who has continued her voluntary work of indexing during the year, and Miss R. Allen, who gave voluntary help in the library from January to March 1957.

Gifts. The Institute is most grateful for the publications sent to the library in exchange for the *Polar Record* and regrets the impossibility of acknowledging each one individually.

We wish to thank the many people and organizations who have so kindly presented the following items:

Books and reprints

K. V. Algvere
A. J. Alter
V. N. Andreyev
Dr M. Anraku
S. Apollonis
Dr T. E. Armstrong
Dr E. Aubert de la Rüe
Dr O. L. Austin, *jr.*
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P. T. Baker
M. B. Bayly
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Falkland Islands and Dependencies Meteorological Service
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Zoological Society of London
Yukon Territory. The Commissioner

Maps and charts

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Directorate of Overseas Surveys, Tolworth
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Norsk Polarinstitutt, Oslo
U.S. Antarctic Programs, Washington

Photographs, negatives, slides, films, etc.

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South Georgia Survey, 1955–56
United States Coast Guard
United States International Geophysical Year Committee
United States Navy
Vickers Limited, Montreal
Wärtsilä Koncernen A B, Helsingfors
Westralian Farmers Limited, London

Manuscripts, etc.

Plans of the special sleeping hut Mark IV, constructed at Mawson, Australian Antarctic Territory, 1956; track charts of M.V. *Kista Dan*, Australian National Antarctic Research Expeditions, 1956 and 1957	Antarctic Division, Department of External Affairs, Melbourne
Papers and minutes of the Antarctic Place-names Committee, 1948–56	Antarctic Place-names Committee, London
Typescript copies of letters of Sir John and Lady Franklin and others, in the possession of the donor	W. Keatinge Clay
Concert and lecture programmes designed by Dr E. A. Wilson, British National Antarctic Expedition, 1901–04; track chart by Dr E. A. Wilson of the outward voyage of the *Discovery*, British National Antarctic Expedition, 1901–04	Mrs H. T. Ferrar
Maps, diagrams and charts relating to U.S. Operation "Deep Freeze I", 1955–56	Lieut.-Cdr. M. J. Foster, R.N.

Original plane table sheet of Gough Island; four books of survey observations and computations made during the Gough Island Scientific Survey, 1955–56; sketch chart of Gough Island by F. A. Worsley, with additions by M. T. Scott, drawn by A. B. Crawford, 1955	J. B. Heaney
Plans of M.V. *Oluf Sven*	Hunting Aerosurveys, Limited, London
Letter from Sir Joseph Dalton Hooker to Professor T. Rupert Jones, 1875	Mrs V. St C. Kirk
"The Victorian visitors"; typescript extracts and comments on the Sandwich Island letters of Lady Jane Franklin and Sophia Cracroft, by A. L. Korn, 1956	Professor A. L. Korn
Record of ornithological observations made during Antarctic voyage of factory ship *Southern Harvester*, 1955–56	Neil MacLeod
List of "plants and animals found in the voyage to the North Pole": note-book kept probably by John Phipps, during the British arctic expedition of 1773	Marlborough College
Letter from Nobu Shirase to Y. Kimura, 1933; plans of the Japanese Antarctic I.G.Y. station, 1956	Nippon Polar Research Institute, Tokyo
Journal of William Forrest, kept during a whaling voyage from Dundee to Greenland, 1896	Mrs J. Pacitti
Photocopies of records and profiles of seismic soundings made in Dronning Maud Land during the Norwegian–British–Swedish Antarctic Expedition, 1949–52	Dr G. de Q. Robin
Constructional drawings of sledge meter supplied to Commonwealth Trans-Antarctic Expedition, 1955	Smiths Industrial Instruments, Limited, London
Graph showing mean accumulation at "Maudheim", Dronning Maud Land, 1950–52	Dr C. W. M. Swithinbank
E. J. Bird's certificate of arctic service, signed by Sir W. E. Parry, 1827; letter from Sir James Clark Ross to E. J. Bird, 9 April 1839	Mrs Rosamund Thomas

Museum exhibits, equipment, etc.

Two water-colours, *c.* 1850, of scenes during one of the Franklin search expeditions	Miss G. V. Barnard
Wet bulb thermometer from Stevenson screen at Cape Royds, Ross Dependency, used during British Imperial Trans-Antarctic Expedition, 1914–17	Lieut.-Cdr. M. J. Foster, R.N.
Reproduction of a water colour by Dr E. A. Wilson	Horniman Museum, London
Sample of "Styrpor" insulating material used in the Japanese huts built in the Antarctic in 1956 for the International Geophysical Year	Nippon Polar Research Institute, Tokyo
Medal to commemorate Henry Grinnell's "Franklin Search" expedition, 1851; proof copies of seven engravings from Elisha Kane's *Arctic Explorations* (Philadelphia, 1856), and other sketches probably drawn by Kane during one of the Franklin search expeditions	Captain W. G. Ruxton, R.N.
Black and white line block entitled "Renar på fjället" by Torsten Follinger	Miss A. M. Savours
Sample ration box and sledging rations as used by South Georgia Survey, 1955–56	South Georgia Survey, 1955–56
Snowshoes designed by Statens Skogsforsknings-institut, Stockholm	Professor U. Y. Sundberg

Office equipment

Roneo duplicating machine	Gough Island Scientific Survey, 1955–56

J. A. STEERS, *Acting Director*

NOTICES

The *Polar Record* is published in January, May and September each year. Contributions, also books and papers for listing in the bibliography of "Recent Polar Literature", should be addressed to the Editor, Scott Polar Research Institute, Lensfield Road, Cambridge, England.

Every effort is made to enable authors of articles to receive proofs, which they are requested to return without delay. Proofs of notes are not normally submitted to authors, except when especially requested.

Twenty-five reprints of articles are supplied free to authors; additional copies, which are provided at cost price, should whenever possible be requested on submitting the contribution. Reprints of notes are not normally supplied.

Correspondence arising out of notes and articles is welcomed.

The Scott Polar Research Institute is a signatory of the Royal Society's "Declaration on fair dealing in regard to copying from scientific periodicals". Details of the Declaration may be obtained upon application from the offices of the Royal Society, Burlington House, London, W. 1.

The cover of the journal is from a photograph by Hunting Aerosurveys Ltd., taken during the Falkland Islands Dependencies Aerial Surveys Expedition, 1955–57.

PUBLICATIONS FOR SALE AT THE SCOTT POLAR RESEARCH INSTITUTE

Scientific Reports of the Terra Nova expedition, 1910–13

Reports dealing with meteorology, terrestrial magnetism, gravity determination, aurora observations, physiography and miscellaneous data are still available. For a detailed list, and prices, see the inside back cover of the *Polar Record*, No. 44.

Back issues of the Polar Record

A few sets of the *Polar Record*, Volumes 1–5 (Nos. 1–40), including indexes, are available, price £60 at the discretion of the Editorial Committee; also the following separate issues at seven shillings and sixpence each:

Nos. 1, 2, 3, 4, 17, 19, 31, 32, 39 onwards.

Nos. 33/34, 35/36, and 37/38. These are double numbers and are fifteen shillings each.

Indexes for Volume 1 (Nos. 1–8), Volume 2 (Nos. 9–16) and Volume 3 (Nos. 17–24) are five shillings each, the index for Volume 4 (Nos. 25–32) is ten shillings, the index for Volume 5 (Nos. 33/34–40) is free and the indexes to Volume 6 (Nos. 41–46), Volume 7 (Nos. 47–51) and Volume 8 (Nos. 52–57) are ten shillings each.

Reprints of "Recent Polar Literature", from Nos. 37/38 onwards, are two shillings and sixpence for two reprints for each issue.

Reprints of "Illustrated Ice Glossary", by Terence Armstrong and Brian Roberts, from Volume 8, No. 52, 1956, and Volume 9, No. 59, 1958, are five shillings each.

Reprints of "Chronological list of Antarctic expeditions", by Brian Roberts, from Volume 9, Nos. 59 and 60, 1958, are seven shillings and sixpence each.

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PRINTED IN GREAT BRITAIN AT THE UNIVERSITY PRESS, CAMBRIDGE
(BROOKE CRUTCHLEY, UNIVERSITY PRINTER)